DECEMBER 1956

THE WELDING JOURNAL

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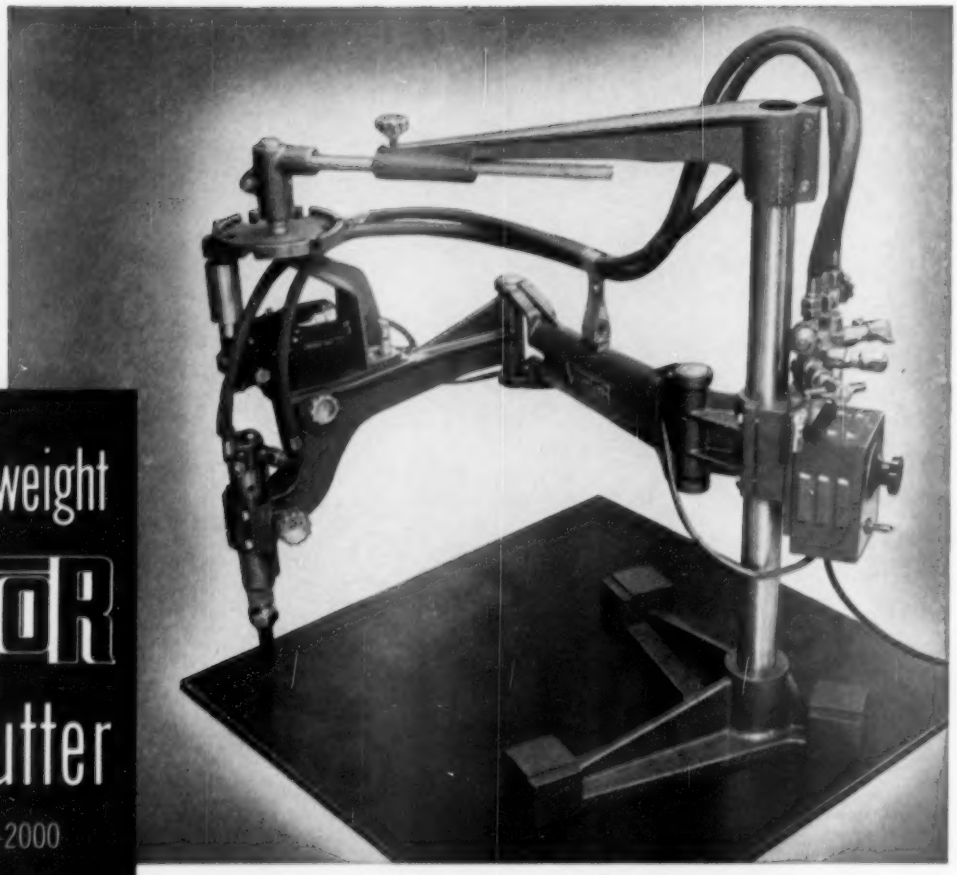

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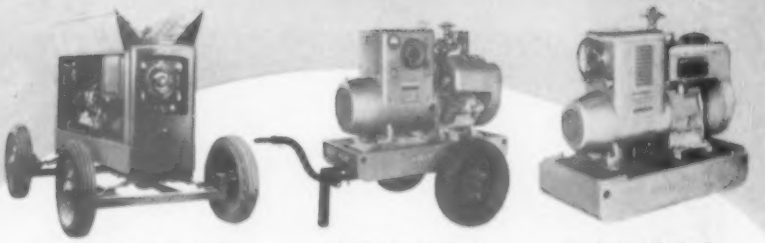

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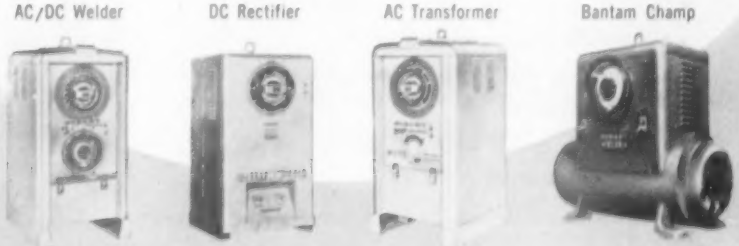

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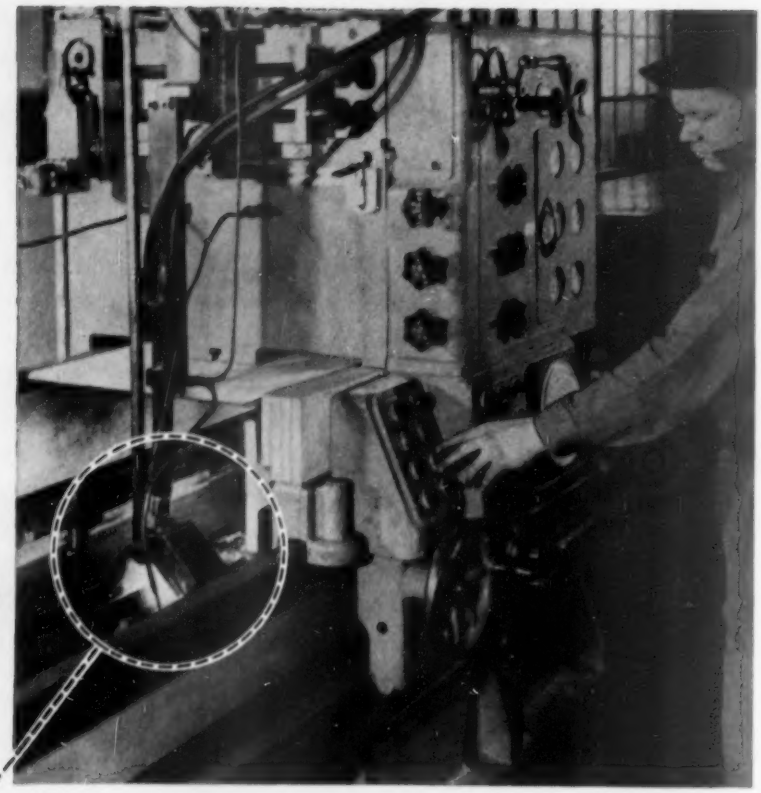

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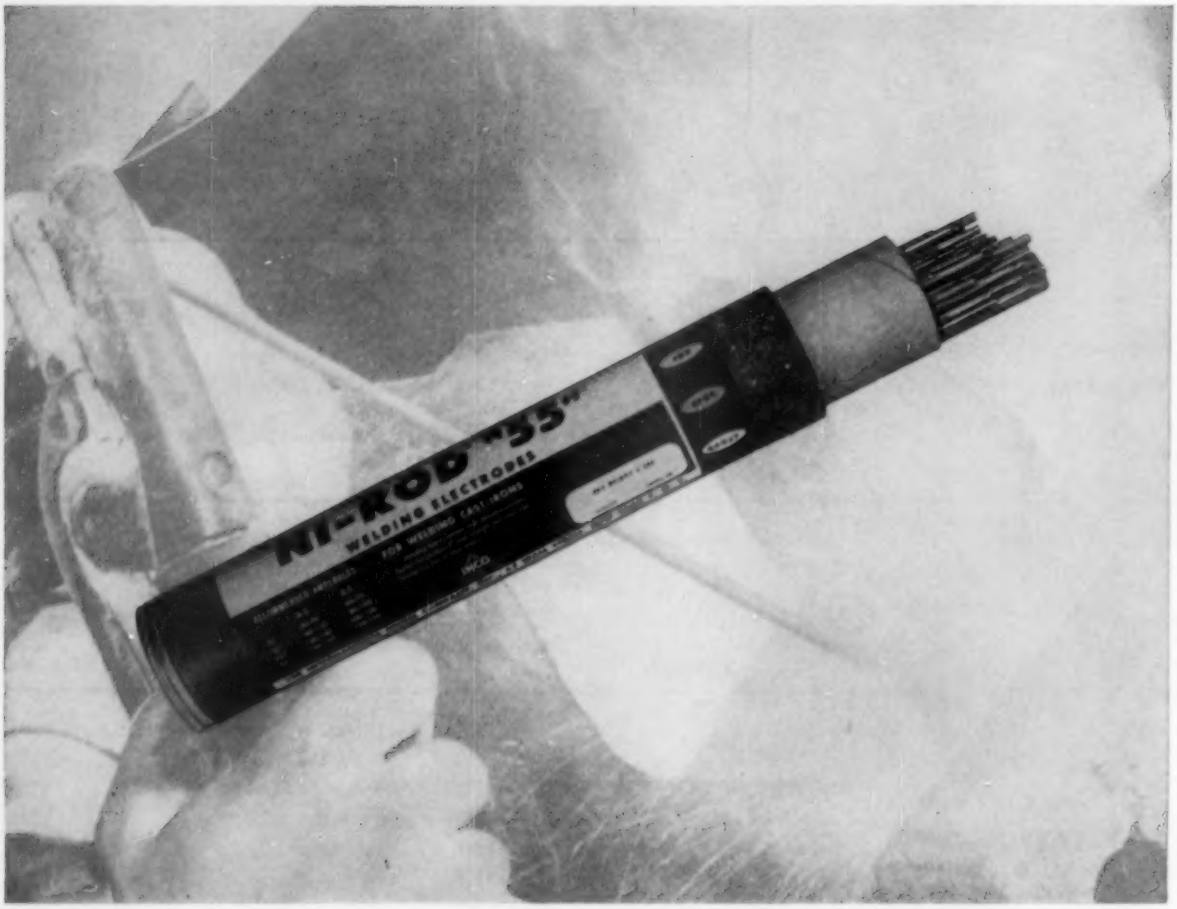

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EDITORIAL

EDUCATION FOR WELDING

In 1900, the ratio of engineers and scientists to production workers was 1 to 250, today it is 1 to 50; tomorrow the need for engineers will be still greater. Early in the century, education for welding consisted of the old master transmitting his art to the apprentice; today the process of education for welding must be speeded up to meet the broad demands of modern technology. Today the lowest cost production methods should be used—too often less efficient means of fabrication are employed because education for welding has not kept pace with the growth of industry. More welding would be used if more men knew how to weld and how to apply welding to engineering structures.

The interest in education for welding is growing; this interest should be inspiring to the members of the AMERICAN WELDING SOCIETY. Our nearly 12,000 members and the thousands of men in related trades are demanding more welding "know-how." It is visualized that today's dynamic growth of industry will, in the next few years, require 100,000 welders with the accompanying technically trained men to accomplish the new engineering tasks.

The AWS is fully cognizant of this need and has recently reorganized the Educational Activities Committee. The scope of this Committee is "to improve the education and usefulness of personnel engaged in and associated with welding." The many AWS members who have rallied to the support of this activity reflect the interest, the need, and the hopes for progress through "Education for Welding." There is need for clear-cut instruction courses and programs for use in the Section as well as for in-plant training, for trade school, technical institute, college, and extension training. We have a task ahead of us that will challenge the best from our members in order to provide the ideas, time and finances required.

"Education for Welding" is a problem we cannot set aside as being entirely an educator's problem. It is our problem. Those with an intimate working knowledge of what is needed are the men who must join hands with the educators to show progress. Immediate action through Section educational effort should be geared to a longer-range effort from the District, National and International standpoints.

Our industrial progress can be assisted by "Education for Welding."

Clarence E. Jackson
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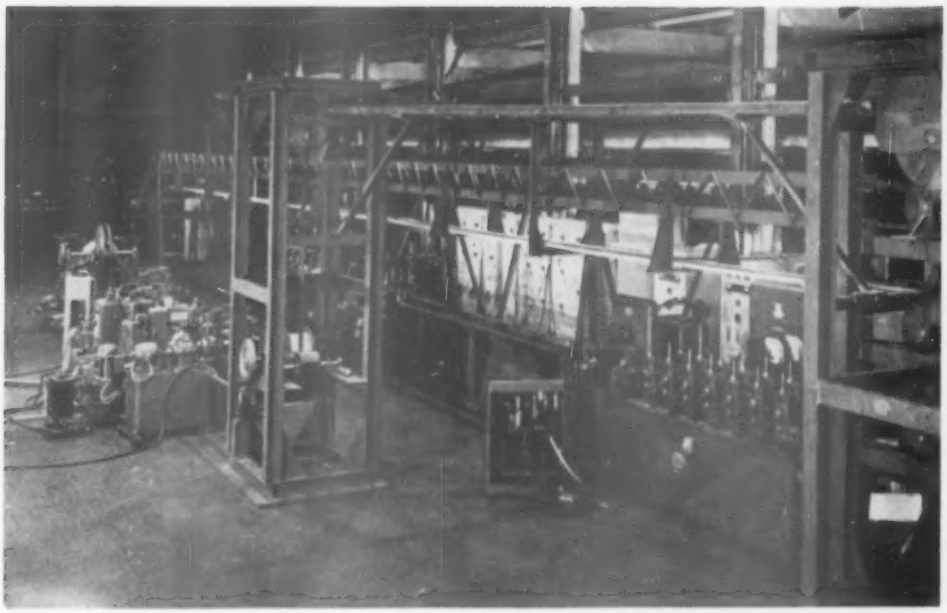


High-frequency induction welding of electrical conduit with 10,000 cycles at 300 fpm

HIGH-FREQUENCY CONTINUOUS SEAM WELDING OF FERROUS AND NONFERROUS TUBING

New materials, faster welding speeds, higher quality of weld and ability to weld thinner-walled stock are claimed as advantages for the high-frequency process

BY H. B. OSBORN, JR.

H. B. Osborn, Jr., is Technical Director, TOCCO Division, The Ohio Crankshaft Co., Cleveland, Ohio.

Presented at the 1956 AWS National Fall Meeting in Cleveland, Ohio, October 8th to 12th.

Introduction

The application of high-frequency (well above 60 cycles) electrical energy to the continuous electrical seam welding of tubing has introduced into this field many new advantages. These include:

1. Increase of several hundred percent in welding speed.
2. Use of hot-rolled material.
3. Accurate control of upset.
4. Welding of materials other than steel.
5. Welding of extremely-thin-wall stock.
6. Greater flexibility and less maintenance.

The high-frequency energy may be applied to the material to be heated for welding by either subjecting the strip or tube to magnetic flux (*induction heating*) which will cause current to flow in the desired areas; or by making direct electrical contact (*resistance heating*) which will also cause current to flow. In either case the resultant I^2R losses develop the heat necessary for welding.

Discussion of Advantages

Increased Weld Speed

When a frequency of 60 cycles, or even 180 cycles for that matter, is used with the conventional low-frequency resistance method, the speed of welding is limited because of the well-known "stitching" effect which appears and which is determined by the frequency.

With high-frequency welding this is eliminated and tube mills are in production processing tubing at the rate of 300 fpm—by the induction method, using 10,000-cycle equipment. Before this was an accomplished fact, a considerable amount of redesign of the mill was necessary for operation at these higher speeds and the present speed is limited only because of the mill. If a mill can be produced which will satisfactorily handle strip (cold) and convert it to tubing, maintaining the close tolerances necessary—even at speeds of 1000 fpm—induction heating can be used for welding.

Surface Condition

The low-frequency contact-resistance method requires a clean surface. Thus it is necessary to use strip which fulfills this specification; that is, a hot-rolled strip which has been pickled or one that has been cold rolled. At higher frequencies, however, this is not a factor and no surface preparation is required. With the induction method where there is no contact made by the "inductor" with the material, it is practical to weld regardless of surface condition, e.g., even hot-rolled skelp. Edge preparation from a slitting operation is recommended in all cases so that the abutting surfaces are clean.

The cost savings to be gained because of the advantage are not applicable if the tubing produced must eventually be cleaned before subsequent use; that is, if plating or other operations follow.

Upset

Characteristic of high-frequency heating is the flow of energy on the surface. Thus, when the heating is confined to the edges of the strip to be welded, proper adjustment of roll pressure and heat pattern makes it possible to control the amount of upset, particularly on the inside where it will be nothing more than a slight bump as contrasted to the rough flash characteristic of conventional resistance-welded tubing. This has been very advantageous in the instance of electrical conduit where a rough flash cannot be tolerated.

Material

Low-frequency resistance mills have been in successful operation for years on ferrous materials, generally low- and medium-carbon steels. Certain other materials such as alloy steel, stainless steel, aluminum, bronze and brass had never been satisfactorily processed. High-frequency induction and resistance mills are now a reality on all these materials.

Thin-Walled Tubing

With rotary electrodes, the heat is necessarily not confined to the very edge of the strip. Thus it had been practically impossible to weld very-thin-walled (less than approx. 0.030 in.) tubing since it cannot withstand the extreme pressures applied. This is particularly true with those having a narrow plastic range such as aluminum.

The high-frequency technique has made it possible to weld tubing but 0.010 in. thick.

Flexibility and Maintenance

Conventional rotary electrodes have to be changed for but slightly different tube sizes. Further these must be refinished or replaced as they become worn.

Neither situation prevails with high-frequency induction welding, thus providing greater flexibility and less maintenance. The contact shoes used for high-frequency resistance welding, because of their size and the handling of less current, enjoy these same advantages.

Forged Welds

High-frequency welding can produce a forged weld as contrasted to a cast weld. By "forged" it is meant that the edges of the seam have been heated to a high enough temperature in the plastic range of the material to be forged together under pressure and at no time has the metal become liquid. The well-known electric resistance weld tube mills employing rotary electrodes cause current to flow by making contact on either side of the seam. The electrical resistance of the seam to the flow of this current melts the abutting edges following which the squeeze rolls press such edges together into a homogeneous structure. This same phenomena occurs with high-frequency induction welding with certain types of inductors and with high-frequency resistance welding. However, with the properly designed inductors and correct welding procedure high-frequency forged welded tubing is being produced. As will be recognized, this is highly desirable from a strength standpoint. Pipe so produced has been approved by the American Petroleum Institute (API) and many miles are already in use.

High-Frequency Resistance Welding

Conventional roller-electrode resistance welders operate generally at 60 or 180 cycles. Higher frequencies permit faster welding speeds as pointed out in a previous part of this paper. There is another advantage though; namely, that, as the frequency is increased the current for equivalent power is reduced due to higher voltages. At 500 kc the advantage may be as much as 100:1. Also, the higher the frequency the more readily can the heat be confined to a shallow depth from the seam edge. However, suitable electrodes must be designed to introduce as much of the current as possible into the seam edges and thus decrease the amount of power needed for a given wall thickness. A further advantage to the lesser amount of metal heated is that smaller diameters and thinner walls can thus be processed. This latter point will be discussed in more detail under "High-Frequency Induc-

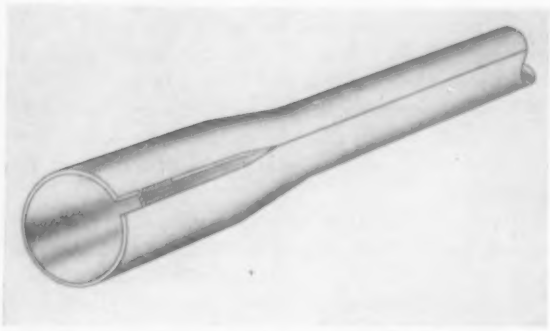


Fig. 1 High-frequency resistance welding with contact shoes. Metallic contacts held against seam edges are connected to high frequency power, and are separated by an insulating member. On small dameters, shoes are against outer surfaces adjacent to seam

tion Welding" since the same reasoning follows regardless of how the high-frequency current is applied.

The fullest advantage is gained when the contact is made only against the seam edges and not by means of flanged roller electrodes which also make contact with the surface of the tube adjacent to the seam edges. That portion of such electrodes which contacts this surface rolls on it, making point to point connection. That portion which contacts the seam edge will slide against it. This, therefore, suggests the use of shoes introduced into the seam providing all current flow through slide contact against the seam edges. On small diameters, due to space limitations these shoes are generally applied to the outer surfaces of the tube adjacent to the seams.

This type of sliding-contact high-frequency resistance welding is being used on a variety of tubing (Fig. 1). Some maintenance problems have been encountered. The edges of the seam as they approach the seam joint present a path for the high-frequency current of relatively low impedance compared to other parallel paths circumferentially around the tube. The current flows to and across the seam joint where heating is of sufficient magnitude to permit welding.

Tabulated below is data on production mills, indicating the present scope of this technique. High frequency used was 50 kw at 450,000 cycles.

Material	*Wall, in.*	*Speed, fpm*	*Material*	*Wall, in.*	*Speed, fpm*
Al	0.025	200	Brass	0.025	112
Al	0.035	200	Brass	0.050	80
Al	0.045	175	Brass	0.080	60
Al	0.051	150	Stainless Steel	0.031	137
Al	0.062	130	Stainless Steel	0.050	110
Al	0.081	110	Stainless Steel	0.109	72

Speed independent of diameter above $^{3}/_{8}$ in. OD and varies considerably with application, e.g. $^{3}/_{8} \times 0.035$-in. steel has been welded at 400 fpm.

High-Frequency Induction Welding

The art of high-frequency induction welding of tubing would appear to be quite old. A patent filed in 1928, and subsequently issued, carries claims which read in part, "The method of continuously welding open-seam metal tubes by induction. . .progressively advancing an open-seam metal tube, bringing the seam edges together into closer and closer proximity during the longitudinal movement thereof until said edges are sufficiently close. . .inducing in the metal a current flow for heating the seam. . .bringing the edges completely together to cause concentration of flow of induced current and impressing the edges together to weld the pipe. . . ."

It sounds very simple, but it has taken many years of research and development and refinement of technique to put the process on a production basis. The refinements have concerned themselves primarily with the design of the inductors used and a thorough understanding and control of the flow of current. These have been sufficiently important to allow the issuance of dozens of additional patents. Thirteen, for example, have been granted to the author's company during the last five years alone. The relative position of the inductor to the tube must be accurately maintained, but the elimination of the need for contacts has been a tremendous advantage.

There are four basic designs used for the inductors. The first, which we shall call "encircling inductors", is nothing more than one or more turns surrounding the tube, generally in advance of the seam junction point. The second, which we shall call "nonencircling" generally consists of an elongated construction held above and parallel to the seam. The third type is a "combination" of the first and second. The fourth type, which we will classify as a "current concentrator," may be a simple looped device or a complex arrangement of it with encircling and nonencircling means. We are, however, quite aware that the expression "current concentrator" could be applied to *any* inductor used.

1. Encircling Inductor. The open-seamed tube is fed progressively through the inductor and is gradually closed to produce a weld from the heat which has developed along the edge of the seams and has concentrated at the seam junction point. There has been considerable controversy in the patent literature concerning the location of this point; that is, whether it is within or without the physical confines of the inductor or within or outside the magnetic field created by the inductor. It is necessary to maintain the seam open as it goes into the coil, and a nonconductive guide is generally used. This also serves the additional purpose of maintaining the position of the seam through the pressure rolls—a very essential control.

The encircling inductor induces, by the usual process of electromagnetic induction, a circumferential flow of current. This current, however, cannot flow across the open seam and, therefore, flows down the tube to the seam junction point. There is an increasing concentration of current density as we approach an

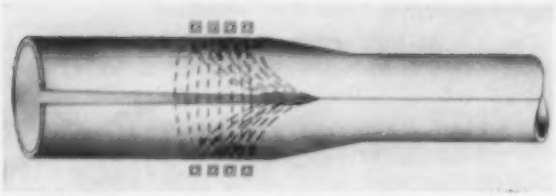


Fig. 2 High-frequency induction welding with encircling type of inductor. Shows 4-turn, water-cooled inductor and current flow induced in tubing

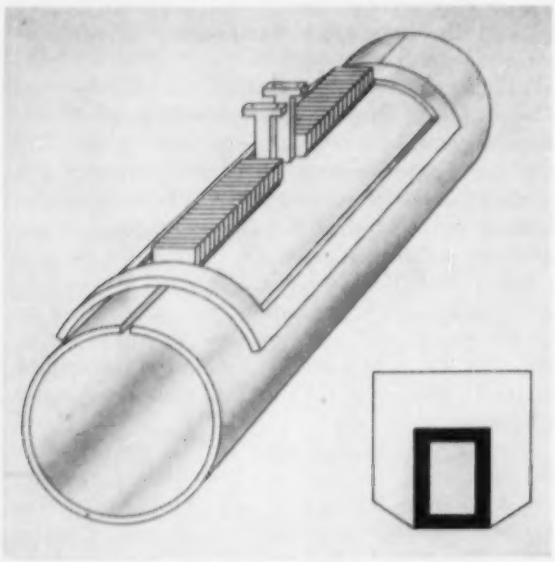


Fig. 3 High-frequency induction welding with nonencircling laminated inductor. Inset shows how U-shaped laminations (0.007 in. thick for 10 kc) are stacked on center leg

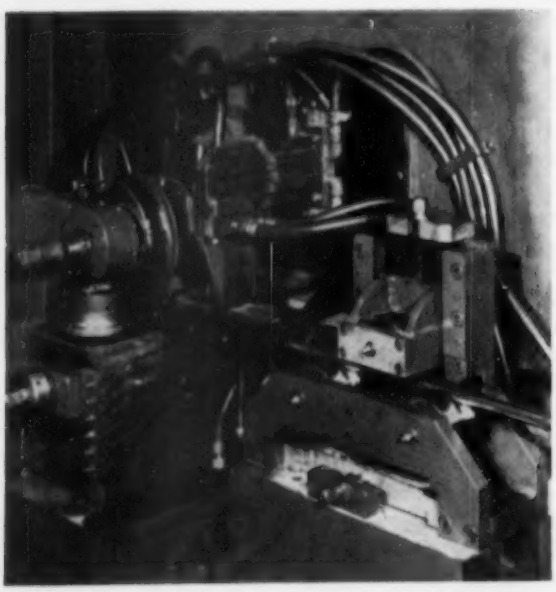


Fig. 4 Induction welding 1-in. steel tubing at 10,000 cycles with inductor shown in Fig. 3

intense concentration and arcing at this point which produces sufficient heat to melt the metal which is instantly pressed together and welded (Fig. 2).

While the current flow is concentrated essentially in the seam edges, this design produces some flow of current in all portions of the tube at some sacrifice in efficiency.

Inductors of this type have been used at various frequencies and on both ferrous and nonferrous materials. However, they have been most successful in the welding of thin-walled nonferrous tubing, generally aluminum, and operating from a vacuum-tube oscillator at approximately 450,000 cycles.

Tabulated below are data on production mills, indicating the present scope of this technique.

Material	*Tube size*		*Power, kw*	*Welding speed, fpm*
Wrought iron	1 in. diam	× 0.012 in.	35	75
Aluminum*	1 in. diam	× 0.050 in.	50	100
Aluminum	4 in. diam	× 0.049 in.	19	160
Aluminum	1 in. diam	× 0.049 in.	17	200
302 Stainless steel	1 in. diam	× 0.064 in.	25	68
304 Stainless steel	5/8 in. diam	× 0.020 in.	18	100
70/30 Brass	1 1/2 in. diam	× 0.035 in.	16	150

* Data for 1-in. aluminum tubing shows wide discrepancy (6:1) due to quality requirements.

2. Nonencircling Inductor. The open-seamed tube is fed progressively under the inductor and is gradually closed to produce a weld from the heat which has been developed along the seam edges. The point at which

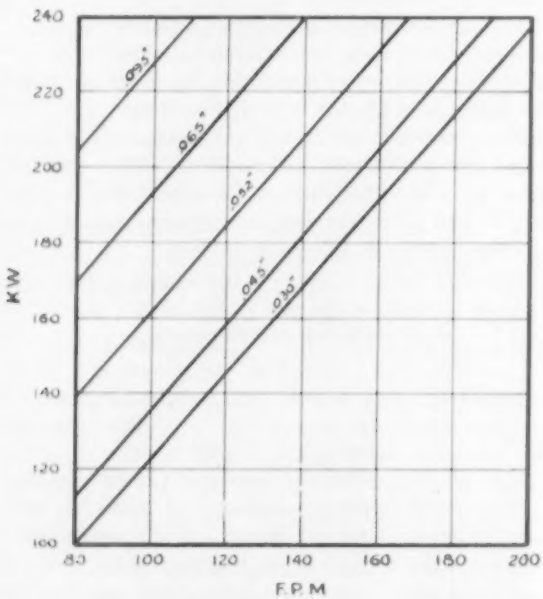


Fig. 5 High-frequency induction welding low-carbon steel tubing at 10,000 cycles. Power vs. speed for various wall thicknesses and 1/4 in. OD or larger. Lines are averages of a scatter of a large number of production runs. (0.080 in./0.100 in. in air gap).

the seam is closed may be under the inductor or after the tube has left the inductor, just so long as the temperature is high enough when the pressure rolls "forge" the edges together.

With this design, a seam guide is advantageous to provide an open seam as the strip goes under the inductor and to control the position of the seam in the pressure rolls. However, it is absolutely necessary to have this guide to accurately position the seam with respect to the inductor so that the edges to be heated are kept beneath the center leg of the inductor which carries a flux concentrating device. This heats a minimum depth of metal back from the seam edge which results in the small amount of upset.

This type inductor usually consists of three parallel conductors with the center conductor opposite the edges of the seam to be heated and provided with magnetically permeable material so as to induce high-frequency current in the edges of maximum concentration or density. The other two conductors are spaced away from the edges but more or less adjacent to the surface of the tube so as to create electrical coupling and induce current in that area, but at low density (Figs. 3 and 4). (In some installations these side arms are remote to the tube surface even above the level of the central conductor in order to provide easier clearance for the pressure rolls.) An air gap of approximately 0.080/0.100 in. is maintained between the tube and the center leg.

Tabulated below is representative data on production mills indicating the present scope of this technique for low- and medium-carbon steel.

Frequency	*Tube size*	*Power, kw*	*Welding speed, fpm*
4,000 cycles	2 in. diam × 0.020 in.	200	200
8,300 cycles	1 1/2 in. diam × 0.150 in.	600	200
10,000 cycles	1/2 in. diam × 0.049 in.	250	200
10,000 cycles	2 in. diam × 0.065 in.	250	150
10,000 cycles	8 5/8 in. diam × 0.141 in.	130	25

A similar set of data for E.M.T. conduit welded at 10,000 cycles using 270 kw is as follows:

Tube size, in.	*OD, in.*	*Wall, in.*	*Welding speed, fpm*
1/2	0.706	0.042	210
3/4	0.922	0.049	200
1	1.165	0.058	180
1 1/4	1.510	0.065	150
1 1/2	1.740	0.065	150
2	2.197	0.065	150

The mill processing conduit per the above data has in operation since 1950 and averages approximately 50,000,000 ft per yr. The strip-to-conduit yield is 96%. This figure includes trimming losses for the wide coils, material consumed for test set up on size changes and end weld losses.

The chart identified as Fig. 5 shows the power requirements at 10,000 cycles for welding various sizes of tubing at relatively high speeds. At lower speeds, heat loss by conduction circumferentially reduces efficiency considerably.

The air gap between the inductor and the seam affects the efficiency of welding. Pipe has been run at 10,000 cycles with an air gap considerably less than that applicable to the above data. Compare, for example:

Diam., in.	*Wall, in*	*Power, kw*	*Speed, fpm*	*Air gap, in.*
4	0.187	100	30	0.040/0.050
8 5/8	0.141	130	25	0.080/0.100

With the smaller gap, more metal has been welded with less power and at greater speed. The improvement has been about 100%.

Unfortunately, it has been found impractical to maintain, on a continuous production basis, the small air gap indicated above. Further, under such conditions momentary changes in gap corresponding to deviations of the seam from parallelism with the inductor result in undesirable temperature variations. Additionally, scale from hot-rolled strip will introduce serious problems by often filling up the gap despite wiping and blowing devices. Although at considerable loss in efficiency, these difficulties are not encountered at the 0.080/0.100-in. air gap which is recommended for production.

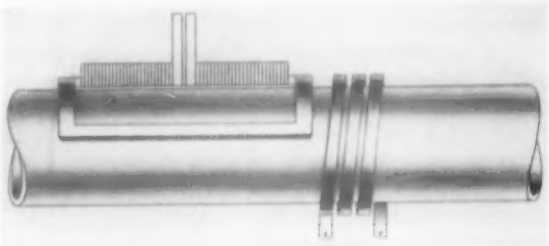


Fig. 6 High-frequency induction welding with combination of inductors

3. Combination. When using the nonencircling inductor at reduced welding speeds and at low power, the seam edges may cool during the slight interval between leaving the inductor and entering the pressure rolls. This interferes with obtaining a perfect weld. If the temperature is raised to overcome this deficiency, the edges may melt and a cast weld will result, losing the advantage of a forged weld (roll pressure requirements will also change).

The combination design comprises the use of the nonencircling type inductor described above to preheat the edges to a temperature just below welding, plus an encircling type through which the tube immediately passes as a result of which the seam joint is brought to welding temperature by the same process as shown in Fig. 2. However, in this instance there need be no melting take place, as when using the encircling type alone, since the edges, being already at a high temperature, have a high resistivity; thus, with

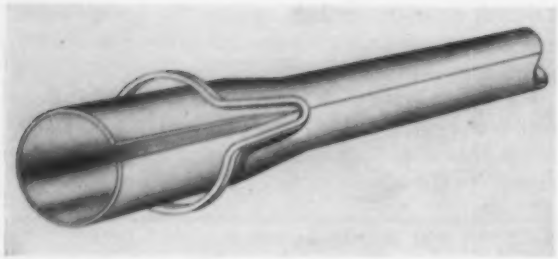


Fig. 7 High-frequency induction welding with encircling type inductor modified to concentrate current at seam joint

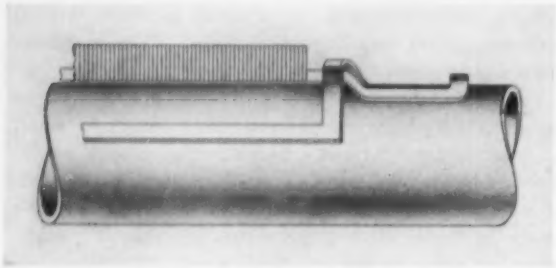


Fig. 8 High-frequency induction welding with nonencircling inductor to which current concentrator has been added

less current flowing, there is no tendency to melt at the junction point (Fig. 6).

4. Current Concentrator. Admittedly, all inductors used in the induction heating field are basically current concentrators—as are certain parts of specially designed inductors. However, the connotation here is meant to apply to devices intended, by special techniques, to concentrate the current in the area of the seam joint much the same as accomplished by the "encircling" type described above but more efficiently.

The simplest approach to this is to change the shape of an encircling type of inductor so that it conforms to the shape of the seam joint region. This corresponds to introducing a loop or hairpin parallel to the seam which will cause an increase in the current flow by the closer proximity of the inductor legs or loop to the edges to be heated (Fig. 7).

The same idea may also be applied as an added feature to the nonencircling type (Fig. 3) as described above where a loop is added to bring about final heating after a preheat under the inductor (Fig. 8).

There have been many other developments which include such things as a second inductor on the inside of the pipe or just a stack of high-magnetic permeability material directly under the seam. However, a thorough study of all these factors and the several inductors described so far, along with modifications thereof, has resulted in the adoption of a slightly modified concentrator which had been used successfully for many years for induction-heating requirements such as surface hardening and brazing. For the purpose of this paper, we shall call it the "current concentrator."

Basically, it consists of a "primary," multiturn coil accurately matched to the output of the high-frequency generator; a "secondary" device efficiently coupled to this primary and connected to a loop positioned over and in advance of the seam joint. The multiturn coil (primary) may, for convenience, encircle the tube or, if preferred, be adjacent to it (Fig. 9). The "secondary" partially encircles the tube in advance of the seam joint, but it is within the "primary." The loop is in series with the "secondary" and carries a high current flow. Its shape and position over the seam and joint and close proximity thereto results in a corresponding current flow in the seam edges and across the joint which is readily controlled to produce the correct "forged" welding temperature. While temperatures can be made sufficiently high to produce melting, this is intentionally avoided so as to preclude the formation of undesirable cast structure.

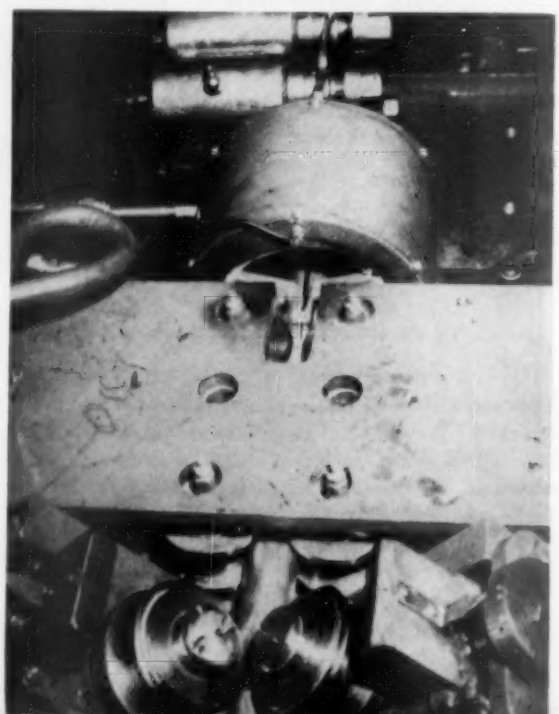
The concentrator is suitable for various frequencies but is currently being used primarily at radio frequencies welding small and medium-sized thin-walled nonferrous tubing which heretofore could not be welded successfully. Tabulated below are welding data on tubing processed with the concentrator at a frequency of approximately 450,000 cycles.

Material	*Tube size*	*Power, kw*	*Welding speed, fpm*
304 Stainless steel	$1^1/_4 \times 0.050$ in.	18	60
304 Stainless steel	$1^1/_4 \times 0.046$ in.	20	80
Aluminum	$1^1/_4 \times 0.049$ in.	10	80
Aluminum	$1^1/_4 \times 0.046$ in.	20	77
70/30 Brass	$1^1/_4 \times 0.062$ in.	20	27
70/30 Brass	$1^1/_4 \times 0.062$ in.	50	150

NOTE: Aluminum—10 kw produced weld for structural tubing whereas 20 kw needed for high-pressure pipe.

NOTE: Brass—150% increase in power resulted in 450% greater welding speed due to less heat flow by conduction from edges to body of tube.

Fig. 9 Induction welding with current concentrator



Frequency

So far in this presentation little has been said of the effect of frequency. This factor is of the utmost importance and must be taken into account in connection with the wall thickness of the material.

The higher the frequency, the shallower will be the depth of penetration of current and resultant heat. When considering this "depth" as being from the edge of the seam inward circumferentially, it would appear that it would be desirable to use as high a frequency as possible. Certainly, at least approximately 450,000 cycles as available from standard commercially produced oscillators. The limiting of the amount of metal heated makes for better upset control and lower power. When welding thick-walled tubing, the "depth" from the standpoint of measurement from the surface inward radially, must also be taken into account. One might thus conclude that, in such cases, a low-frequency of say 1000 cycles should be used. However, if the frequency selected has a depth factor many times greater than the wall thickness, inefficiency will result because there is not enough metal present upon which the magnetic flux can react and through which the induced current can flow. With depth factors much less than the wall thickness, heat flow by conduction must be relied upon. Since this is slow, the frequency cannot be too high. Thus we must consider the relationship between wall thickness and frequency. For reference purposes the tabulation below shows the approximate depth of penetration in steel heated to welding temperatures for several frequencies.

Frequency, cps	*Depth, in.*
1,000	0.728
3,000	0.420
10,000	0.230
20,000	0.163
450,000	0.034

For the most efficient heating, the frequency selected should have a corresponding depth factor which is approximately the same as the wall thickness. But since it is only practical to use commercially available and economically justified high-frequency generators, and a given mill will probably be used for a wide range of wall thicknesses, a compromise is necessary. The ideal frequency as shown above may be estimated from the equation:

$$F = \frac{530}{D^2}$$

where

F = frequency,
D = depth, in.

According to the above data, the ideal wall size for 10,000 cycles is 0.230 in. When welding much thinner stock the efficiency becomes considerably less. Figure 5 shows this quite clearly. At 150 fpm 180 kw is needed for 0.030-in. wall, whereas a 0.045-in. wall—an increase of 50% in metal—uses but 193 kw (an increase of less than 10%). Similarly, it must be noted that the 0.095-in. wall—an increase of over 200% in metal—uses but 285 kw (extrapolated) (an increase of but 48%).

Conclusions

High-frequency continuous seam welding of tubing has opened up new opportunities for better and cheaper production of tubular stock. New materials, faster welding speeds, higher quality of weld, and particularly being able to weld thinner-walled stock, has justified the installation of many new tube mills during the past few years, simply because of the application of high frequency.

This paper has dealt almost exclusively with the several technical aspects of the welding action which takes place in a space of but a few inches on an installation occupying many feet. While some rather casual reference has been made to air gap, to the alignment of seam and pressure rolls, it must be pointed out that the success of high-frequency welding can only be achieved with proper adjustment and control of all the factors governing the forming of the tubing, matching of the abutting edges of the seam, and control of the position of the inductor. At high operating speeds, the fullest advantage can be taken of high-frequency welding, but the average tube mill does not generally operate this fast; if it is just speeded up, it will not hold the close tolerances required. Taking a conventional mill, replacing the welding heads with high-frequency induction equipment as described in this paper, and then increasing the speed does not make a high-frequency mill. Conversions, if contemplated, should only be undertaken by the mill manufacturer or by a user with the full knowledge of the necessary requirements and the technical help to accomplish them. Also, one should be aware that the design features of the inductors and processes described in this paper and many modifications thereof are covered by patents.

This technique for welding of tubing has been a real challenge to the tube mill manufacturers who have been able to produce the equipment necessary to meet the speed and control specifications of the high-frequency method. The relatively large number of mills in operation or on order today attest to the fact. However, there is still the challenge of higher speeds—certainly, taking a strip and converting it into a tube and then getting rid of it in accurately cut lengths at 300 fpm is quite a task. But as has been stated we are ready to weld at 1000 fpm if and when somebody figures out the "minor" problems connected with a tube mill operating at that speed.

Addendum—High Frequency Annealing of Seam-Welded Pipe

Although the contents of this paper probably should be limited to 'welding" (because of the title), it was

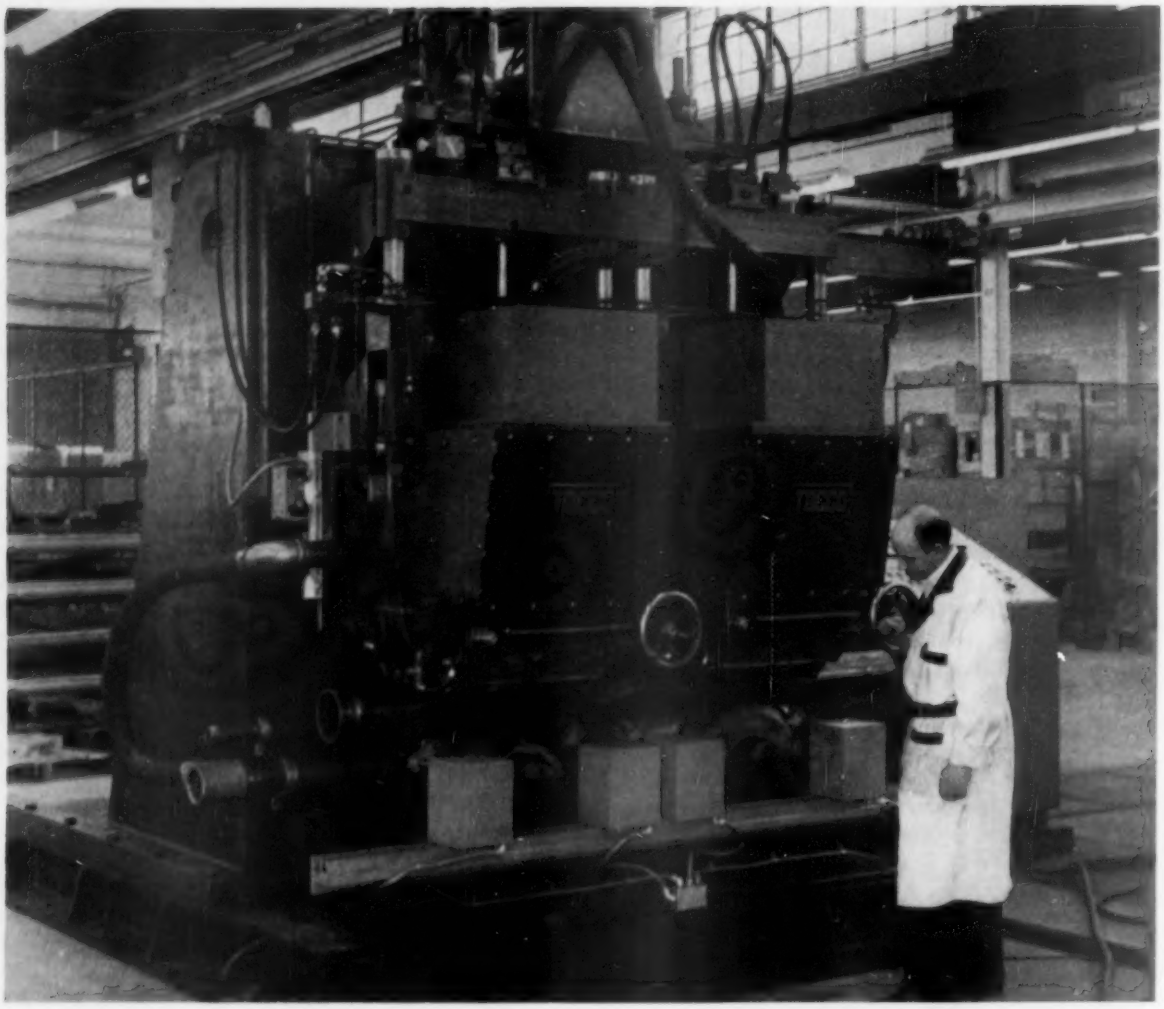


Fig. 10 High-frequency induction annealing of seam-welded pipe. Equipment shown adjustable to handle 4 to 26 in. diam

thought appropriate to add a brief note about the use of high frequency for annealing after welding.

In order to satisfy the physical requirements of certain classes of large diameter (4–26 in.) heavy-walled resistance-welded pipe, the "brittle" cast weld must be annealed. Several old mills have been so equipped with high-frequency units for heating only the weld. Others have resorted to the rather inefficient method of treatment whereby the entire pipe is heated. However, the mills most recently installed or about to be, will, in all probability, use high-frequency seam-weld annealing units (Figs. 10 and 11). The same type of inductor as described in Fig. 3 is used with the side arms positioned above the center leg and the same inductor serves for all diameters.

Acknowledgment

Data contained in this paper is for equipment produced by the Yoder Co., New Rochelle Tool Corp., the MacKay Machine Co. and the tocco division of the Ohio Crankshaft Co. The author wishes to express his appreciation for the cooperation extended by these organizations.

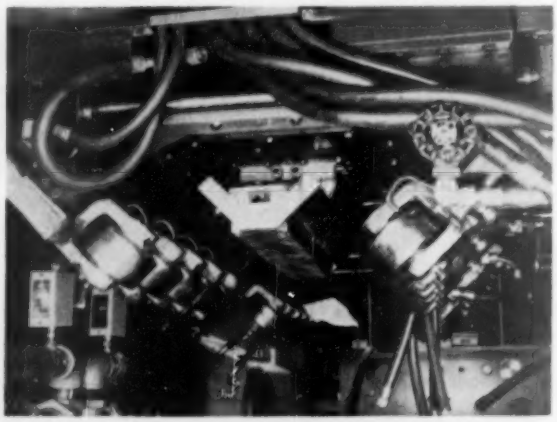


Fig. 11 Close-up of inductor and guide rolls of equipment shown in Fig. 10

NEW IRON-POWDER ELECTRODES AND THEIR APPLICATIONS

Fast fill, fast follow, fast freeze and weldability are listed among the requirements to be considered when selecting an electrode for a given application

BY ROBERT SHUTT

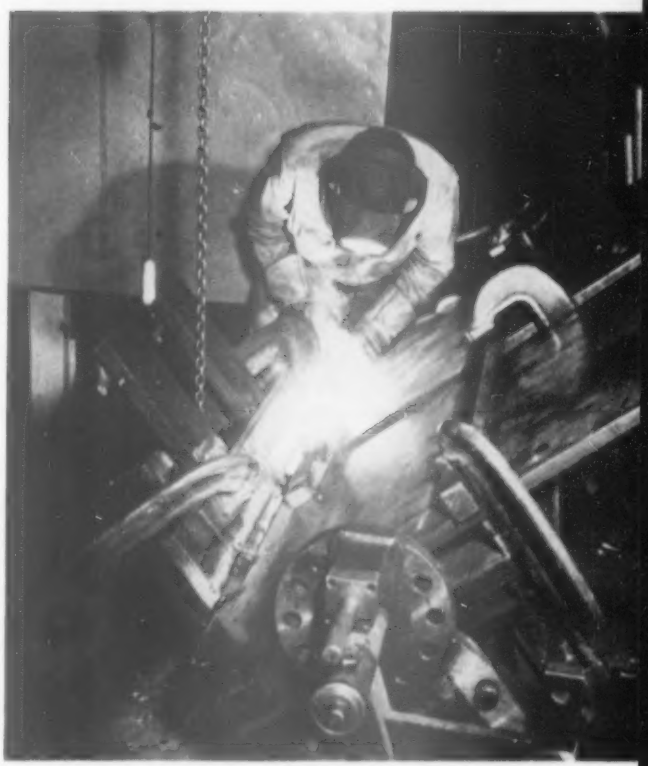


Fig. 1 An E6024 electrode is used to weld the inner ends of wide steel forks of a shop truck at right angles to a supporting strip. The $^{5}/_{8}$-in. downhand fillet is made in 1-in. mild, steel material, using a $^{1}/_{8}$-in. diam electrode

Introduction

Iron powder has been accused of complicating the hand-welding electrode business. The engineer selecting mild-steel electrodes for his plant has almost twice as many electrodes to choose from today as he did four years ago. This makes no one happy. The welding engineer wants the fewest number of electrodes in his plant which will take care of the welding to his satisfaction. The electrode manufacturers would like to make and sell one electrode which would take care of all of the welding to the satisfaction of the welding engineer.

If these statements are true, why are we apparently going in the other direction by adding so many new electrodes?

The answer is simple.

Electrode manufacturers want to make welding more attractive as a means of fabrication. This is accomplished by adding iron powder to electrode coatings. The iron-powder electrodes offer better looking welds at lower costs.

Not many years ago, each family had a family doctor who was a general practitioner. This doctor took care of all the medical needs of the whole family, and life was simple. When anyone in the family had any ailment, the family doctor was called in and he handled the situation to the best of his ability. Today, the small child goes to a pediatrician. The grownups go to a family doctor who diagnoses their trouble and sends them to one of many specialists, depending on whether the trouble has to do with heart, eyes, ears, nose, throat, kidneys, lungs, blood, skin, etc. Life was much simpler when we had only the general practitioner, but our health is getting better care from the specialists, and our life expectancy is steadily increasing.

Back in the early '30's, the E6010 was the general practitioner of the welding industry. By the early '40's, our group of electrodes included such specialists as E6012 and E6013 (high rutile), E6020 (hot rod) and E6015 and E6016 (low hydrogen). This picture remained pretty much unchanged until 1953 when iron-powder electrodes started hitting the market.

At first glance, it appeared that new specialists were being added to the already crowded situation. This,

Robert Shutt is Project Engineer, The Lincoln Electric Co., Cleveland, Ohio.
Presented at 1956 AWS National Spring Meeting in Buffalo, N. Y., May 7–11.

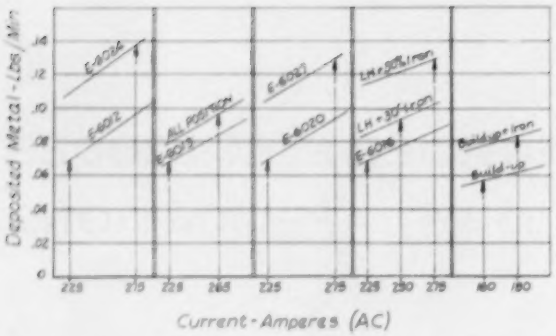


Fig. 2 These deposition rate curves are for the $^{3}/_{16}$-in. size of the various electrodes shown. The arrows indicate usable currents. The curves clearly show how iron powder has raised the usable current and deposition rate in each of the groups. The $^{3}/_{16}$-in. size of the E6024 and E6027 are used in competition with the $^{1}/_{4}$-in. size of E6012 and E6020

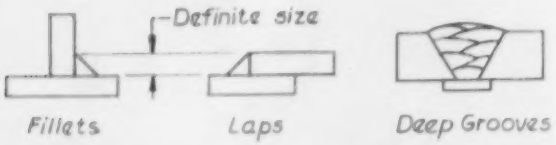


Fig. 3 Fast fill applications are all applications where a definite quantity of weld metal has to be deposited into the joint

however, is not the case. The iron-powder electrodes, when analyzed as to what they do best, are really not new specialists but rather improvements over the already existing specialists. They do the same jobs, but better and faster. They produce better looking welds at lower costs. They reduce costs through higher deposition rates and lower cleaning times. Figure 2 compares the deposition rates of iron-powder electrodes with those of conventionally covered electrodes, illustrating just how large an improvement has been made.

Since these new electrodes are not really new specialists, their correct application is made on the same basic principles as any other type of electrode.

Basic Steps in Selecting the Proper Electrode

Selecting the proper electrode out of the many types of electrodes offered can be rather simple. The following steps are suggestions which will help in selecting the proper electrode for a given application:

1. The design and positioning of the weldment should be questioned first. When the automobile first appeared it met such obstacles as narrow, muddy roads with deep ruts, steep hills and many curves. Some people looked at the roads and decided to stay with the horse and buggy. The people with vision looked at the automobile and changed the roads. They made wide smooth roads and cut down on the number of hills and curves. As a result of this foresight, we have the fast and smooth transportation of our modern superhighways. Engineers with foresight are designing weldments and positioning them in such a way as to make the welding operation easiest and fastest. This, of course, results in lower welding costs.

2. In considering electrodes, new ones should be tested to meet only the requirements of the welding job and not required to be a carbon copy of the product being used. When a product has served a purpose satisfactorily for a number of years, purchasing specifications tend to be based upon the characteristics of that product rather than upon the requirements of the job which it is supposed to accomplish. Consider the job of lighting a room. The kerosene lamp was doing the job, and so some purchasing specifications for new products which would light a room might have read as follows:

(a) Must be portable.
(b) No power failures can result from storms.
(c) If the light source is forgotten, the light must go out in a few hours when the fuel is gone so that an unused light won't remain on and run up the bill.

If Edison had followed these specifications, the electric light never would have been invented. Likewise, if electrode designers had followed existing purchasing specifications, iron-powder electrodes would never have existed. Convention was pushed aside to develop the first E6024 electrode.

The goal of the E6024 development project was to design a hand electrode which would make fillet welds faster and better than they had ever been made. Some of the characteristics of the conventional products which were not copied into the design of the E6024 are:

1. Tensile properties—The E6024 has higher tensile strength than the E6012's and E6013's.

2. Position of welding—The E6024 cannot be used as far from the flat position as the E6012's and E6013's.

3. Electrode size—It is necessary to use a smaller electrode size when using an E6024 than when using an E6012 or E6013.

4. AWS classification—The characteristics of the E6024 are enough different from the E6012 and E6013 so that it was not possible to classify the electrode as either an E6012 or E6013. The new electrode had to earn an AWS classification of its own.

In designing the E6024, convention was discarded in order to do a job better than it had been done before; thus, we have a new and valuable means of fabricating by hand welding.

The welding engineer should, therefore, consider the requirements of the job only in selecting electrodes.

5. Most welding applications may be broken down into these four categories:

(a) *Fast Fill*—These applications are illustrated by the sketches in Fig. 3. They are fillets and deep grooves of a definite size, such that it takes a definite amount of weld metal to fill the welds up to their required size. The problem here is to deposit the required weld metal in the shortest possible time. The answer to the problem is to select an electrode with a high deposition rate. Before iron-powder electrodes,

the choice here would have been E6012's and E6013's for fillets and laps and E6020's for deep grooves.

(*b*) *Fast Follow*—When the size of the weld can be made smaller in order to get higher welding speeds, then an electrode with fast-follow characteristics is used. This amounts to taking a given quantity of weld metal and spreading it thinly over a long length of joint in a very short time. To do this the molten metal crater must have the ability to follow the electrode at relatively fast travel speeds. An extreme case of fast-follow welding with hand electrodes is the lap welding of automobile frames which can be accomplished at the rate of 60 ipm, and where it is not uncommon to weld 48 in. of joint with one electrode. Many of the fast-follow applications are on sheet metal and the best electrodes for these applications are the $^{3}/_{16}$ and smaller sizes of the E6012's.

(*c*) *Fast Freeze*—Vertical and overhead applications require, for ease of welding, that the weld metal solidify or freeze quickly. The undisputed monarch of these applications is the E6010 electrode.

(*d*) *Weldability*—Some steels are high enough in sulfur, carbon or phosphorus to require special consideration in the choice of electrode to produce crack-free welds. Heavier thicknesses of steel also present a problem because of the severe quenching of the welds. This severe quenching may result in cracks. The first consideration in welding these steels is selecting an electrode which will produce crack-free welds. High welding speeds and ease of welding are of secondary importance here. The best selection for these applications is the low-hydrogen type of electrode (E6015 and E6016).

Fig. 4 An E6024 electrode is used to fasten this cast-steel bracket to a tilt bracket made from a 1045 steel channel

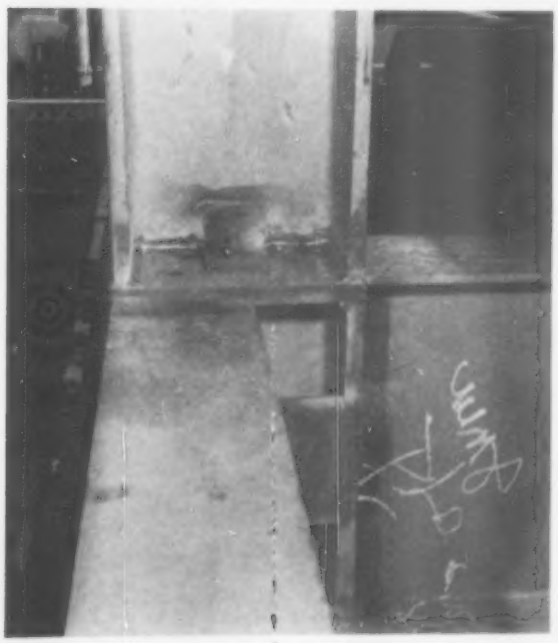


Fig. 5 This field-welded column splice of a multistory structure was made with an E6024 electrode. Fillet welds along flanges are $^{5}/_{8}$ in., and along webs, $^{1}/_{2}$ in.

Evaluation of Iron-Powder Electrodes

The foregoing standards provide a convenient and simple yardstick to classify and evaluate the currently available iron-powder electrodes.

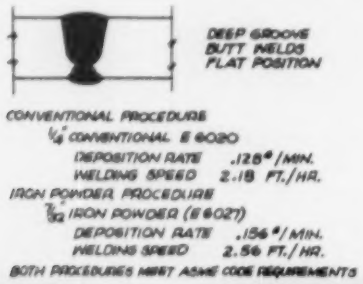
E6024 (High Rutile Plus Iron Powder)

The E6024 was the first of the iron-powder electrodes in this country, and it is the most popular of the iron-powder group.

The E6024 is a fast-fill electrode with some fast-follow and weldability characteristics blended in. It has the highest deposition rate of any of the hand electrodes. When the weld size required is not as large as the normal weld size for the electrode, the E6024 can be made to "scoot" along, giving higher welding speeds and more inches of weld per stick of electrode than any other electrodes except the $^{3}/_{16}$ and smaller sizes of E6012 and E6013's. Some applications, where the weldability of the steel is slightly questionable, require extra precautions in order to weld with E6012's. Most of these "borderline weldability" applications have been handled with low-hydrogen electrodes in the past. Now they are very easily handled with the E6024. The E6024 meets the needs of most of the fillets and laps on steel plate in the flat position. Applications on which the advantages of E6024 electrodes have been used are illustrated in Figs. 1, 4 and 5.

E6027 (Hot Rod (E6020) Plus Iron Powder)

The E6027 is a fast-fill electrode which deposits weld metal with excellent physical properties. The weld metal is X-ray quality, and it exhibits a very high degree of ductility. The transition temperature of the weld metal is as low as that of most low-hydrogen elec-



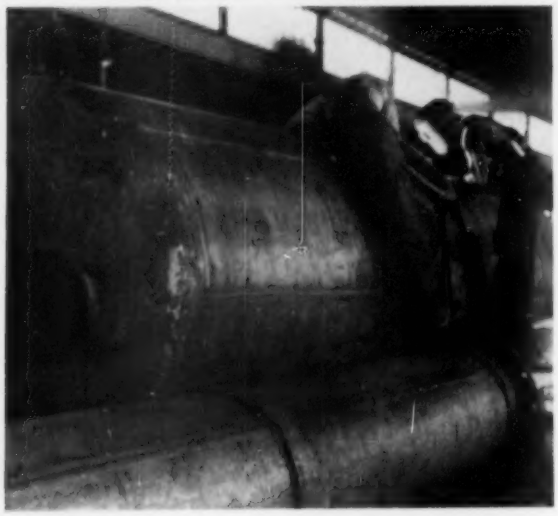


Fig. 6 Type of work for which E6027 electrodes are ideally suited—deep-groove butt welds

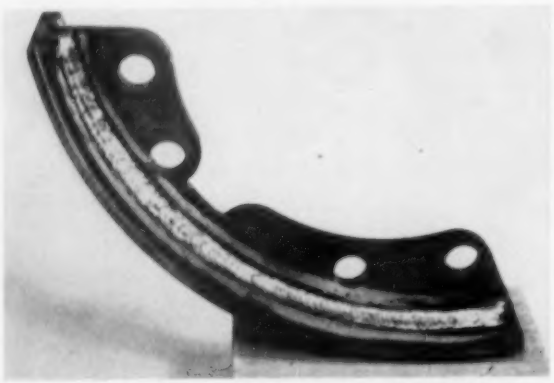


Fig. 7 Production per hour of this axle bumper was doubled by switching from E6012 to the all-position, iron-powder type electrode. Part is welded in position shown with a single $^{5}/_{32}$-in. electrode with 180 amp D C. (American Stamping Co.)

trodes. In addition, the E6027 electrode is better than the conventional E6020 in the following ways:

1. Higher deposition rate.
2. Not as crack sensitive.

The E6027 exhibits the best "all around" slag removal of any of the hand electrodes. There is no such thing as "locked in" slag when using the E6027.

The main applications for the E6027 are multiple-pass butt welds in the flat position. A typical application is illustrated in Fig. 6.

All-Position Electrode (E6013 Plus Iron Powder)

The all-position, iron-powder electrode, a relative newcomer, is a fast-fill electrode with some fast-freeze characteristics. It is growing by "leaps and bounds" in popularity and promises to give the E6024 a good race. The E6024, in making welds 5 to 10 deg away from the flat position, will give the welding operator "slag chasing" problems. The new all-position, iron-powder electrode is not quite as fast as the E6024 in the flat position, but it is faster than conventional electrodes and has enough of the fast-freeze characteristic in it so that welds can be made with it in all positions. Essentially, this new electrode is an E6013 with iron powder added. The advantages of the iron-powder E6013 electrode over the conventional E6013 are as follows:

Slag removal is much better most of the time. At the proper current setting, the slag is practically self-removing.

Arc characteristics are more appealing. The smooth AC-DC arc action of this electrode is characteristic of the iron-powder family.

Less sticking occurs with the small sizes of the iron-powder E6013 than with the small sizes of the conventional E6013. The new electrode is well suited for either contact welding or welding with a short arc.

Bead appearance is better most of the time.

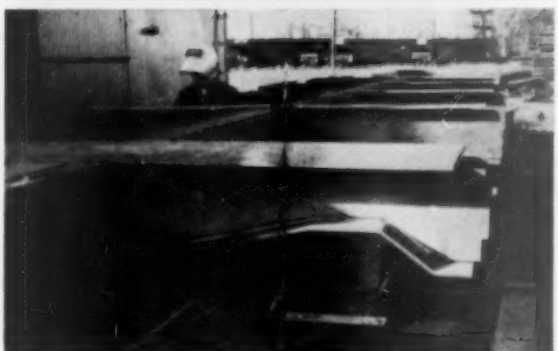


Fig. 8 All-position, iron-powder electrodes are being used here to fabricate cars for steel mill use. Slag is peeling off by itself from joint made at the inclined positions shown. This weldment is the bed of the car. (Ortner Car Co.)

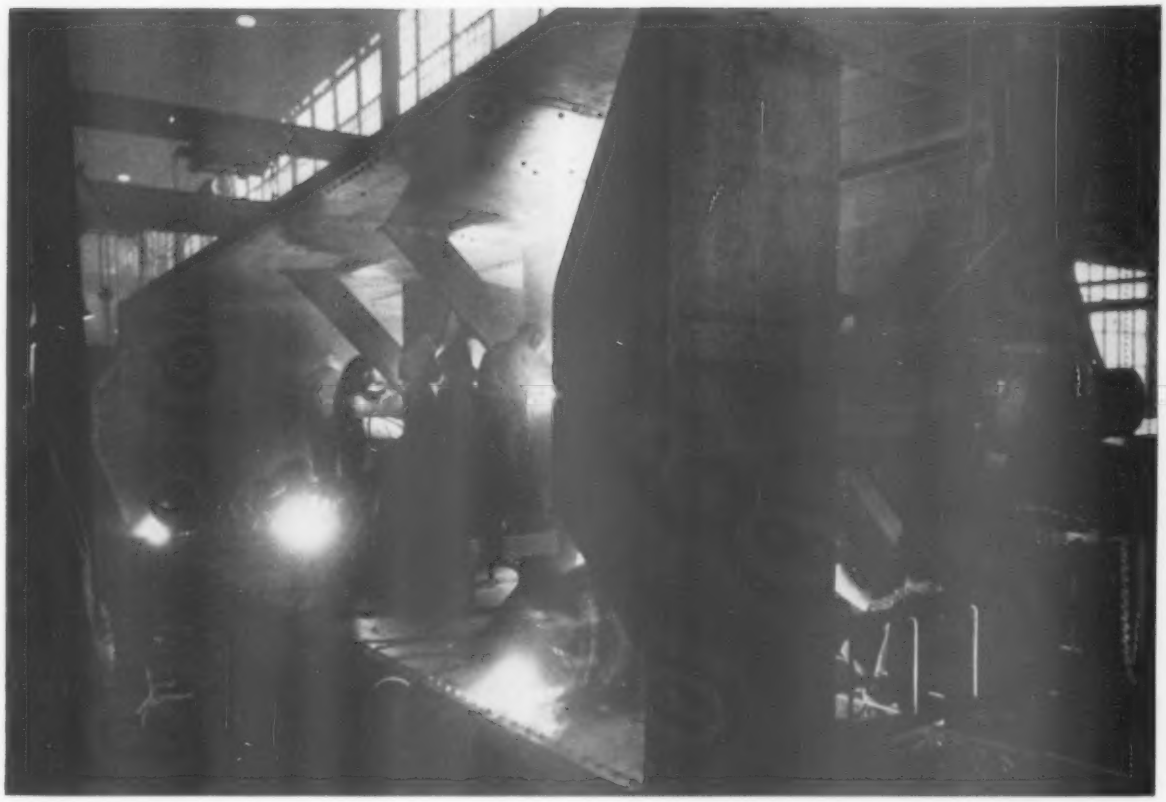


Fig. 9 All-position electrode is employed for all welding on these gondola cars. Cars are removed from their trucks and tipped on their side for the welding crew to enter the body where welds are completed without further positioning. (Greenville Steel Car Co.)

Welding speeds are 10 to 30% higher than those obtained with conventional E6013 electrodes. The greatest differences in arc speeds are found welding downhill.

More inches of weld per inch of electrode result with the iron-powder E6013 electrode compared with the conventional E6013's. This results in fewer electrode changes and a higher operating factor.

Like the other iron-powder electrodes, the all-position, iron-powder electrode has economic appeal for management and much operator appeal for the welders.

While the new all-position, iron-powder electrode is essentially an E6013, it has probably made its biggest advance into the E6012 field. It is a cost saver in this field too, and the operator appeal difference is greater between the E6012 and the newcomer than it is between the newcomer and the conventional E6013.

Typical physical properties of the all-position, iron-powder electrode are shown in Table 1. The properties are equal to conventional E6013's.

The applications for this electrode are the applications of the E6012 and E6013's in all positions. Because of the extra coating on the new all-position electrode, it is more difficult to weld down very steep inclines than it is with E6012's and conventional E6013's.

The AWS classification for the all-position electrode with iron powder will be E6014. Several different types of jobs for which it is well suited are shown in Figs. 7–11.

Iron Powder, Low Hydrogen

Steels with a weldability problem require a low-hydrogen electrode. The problem may be due to hot shortness because of carbon, sulfur or phosphorus, or it

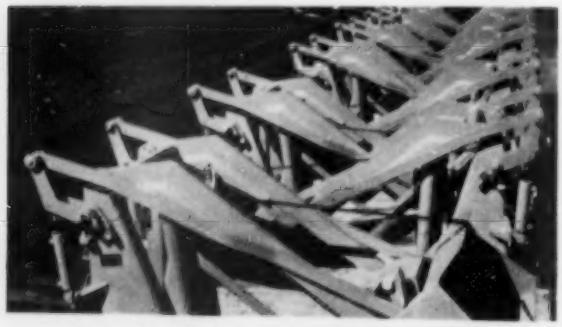
Table 1—Physical Properties (As-Welded)

*Electrode**	*Tensile, psi*	*Yield, psi*	*Elongation, %*
E6012 E6024 E6013 All-position plus iron powder	67,000–87,000	55,000–75,000	17–29
E6020 E6027	62,000–73,000	50,000–61,000	25–30
E6016 Low hydrogen plus 30% iron Low hydrogen plus 50% iron	67,000–83,000	55,000–73,000	22–35

* The build-up electrode plus iron powder gives a deposit with a hardness from 27 to 40 Rockwell C. The actual hardness depends upon the alloy content of the steel being welded and the cooling rate of the weld. The slower the deposit is cooled, the lower the hardness will be and the more machinable the deposit will be.

Fig. 10 All-position operation is illustrated here. Welds are being made in downhand position, as well as at a 30-deg incline. All welds made with $^1/_4$-in. iron-powder electrode, using a-c current. Previous electrode used was an E6012

Fig. 12 The discharge flange of a large pump for a dam project was made of $3^1/_2$-in. firebox plate. This is a typical low-hydrogen, iron-powder electrode application



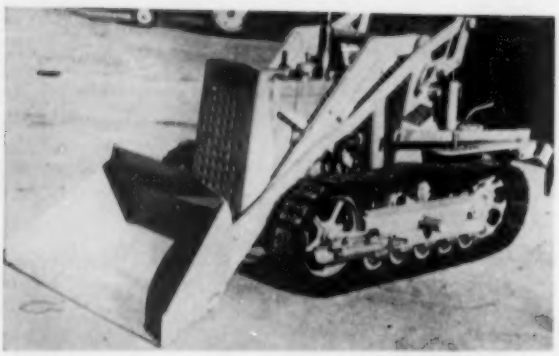


Fig. 11 Parts for earth-moving machinery welded with all-position, iron-powder electrode. (Greenville Steel Car Co.)

may be severe quenching stresses which could result in cracks. Low-hydrogen electrodes are now available with iron-powder coatings to provide varying degrees of the fast-fill characteristic. Two types of iron-powder electrodes are now available. The 30% iron-powder type is for all-position welding and the 50% iron-powder type is for downhand welding.

On heavy weldments which have to be X-rayed, many welding engineers prefer low-hydrogen electrodes to the E6010's. Low-hydrogen electrodes are less susceptible to breakdown at the higher currents that have to be used to get good fusion on heavier steel. Less breakdown results in better X-rays. The new iron-powder, low-hydrogen electrodes operate at still higher currents than the conventional low-hydrogen electrodes. The advantages of the iron-powder, low-hydrogen electrodes over the conventional ones are: higher deposition rates, much better slag removal, better bead shapes, and more operator appeal. Typical uses are illustrated in Figs. 12 and 13.

Iron-Powder Build-Up Electrodes

Iron-powder build-up electrodes are not used for fabrication, but rather for maintenance welding. In recent years there has been a tremendous interest in building up worn parts by arc welding. The iron-powder electrode is making a rapid advance in this field. Typical build-up applications are: Shovel dies, tractor parts (idler, rollers, track links), shovel pads,

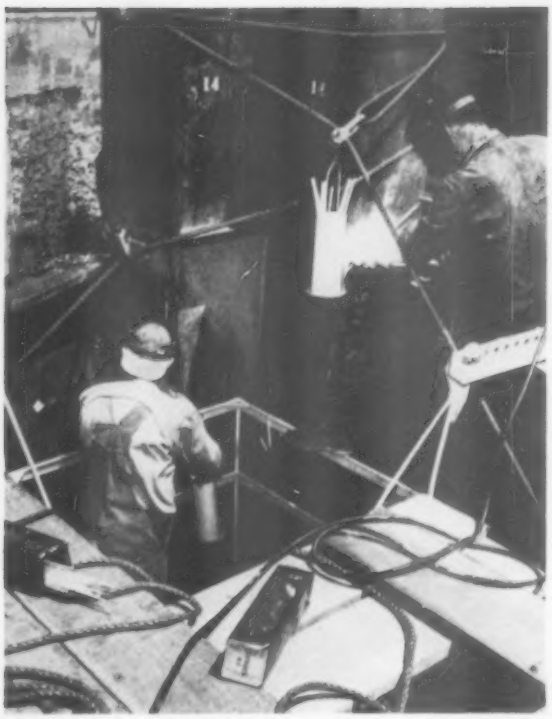


Fig. 13 Low-hydrogen type electrodes were used for making the root pass in the column-girder connections of a large office building in San Francisco. Heavy sections were used because of the seismic loading specifications of the city's building code

cable drums, large trunnions, all shafts (large and small), crane wheels, mine car wheels, and underlay for subsequent application by hard-surfacing materials.

The new iron-powder build-up electrodes are used to build up worn steel parts by producing dense, tough and machinable surfaces of moderate hardness to resist shock and abrasion.

The conventional build-up electrodes have "blustery" arc characteristics and produce quite a bit of spatter. The new iron-powder version has the following advantages over the conventional: higher deposition rates, better slag removal, much smoother arc and much less spatter.

Just as with all of the other iron-powder electrodes, iron powder in the build-up electrode has lowered the cost of the welding operation and has made it easier. Figure 14 is a typical job.

What's Next

What will be new next and when depends largely upon the progressive thinking of engineers responsible for designing and fabricating weldments.

When more weldments are designed and positioned for high speed welding, more emphasis will be placed upon designing electrodes for high-speed welding.

When more purchasing specifications are based upon the actual requirements of the welding application, less time will be devoted to copying old products and more time devoted to developing new ones which will produce better welding at lower costs.

Regardless of what is or is not new in welding, a good rule of thumb in picking the proper electrode for an application is to decide which of the following best describe the needs of the application: (1) fast fill, (2) fast follow, (3) fast freeze, and (4) weldability.

Iron-powder electrodes are replacing conventional electrodes for these applications. The larger sizes of E6012, E6013 and E6020 are losing their popularity and may eventually become obsolete. The present, with its double set of electrodes, is merely the interim between the recent past, with its one set of electrodes, and the future, which will probably be reduced to one set of improved electrodes.

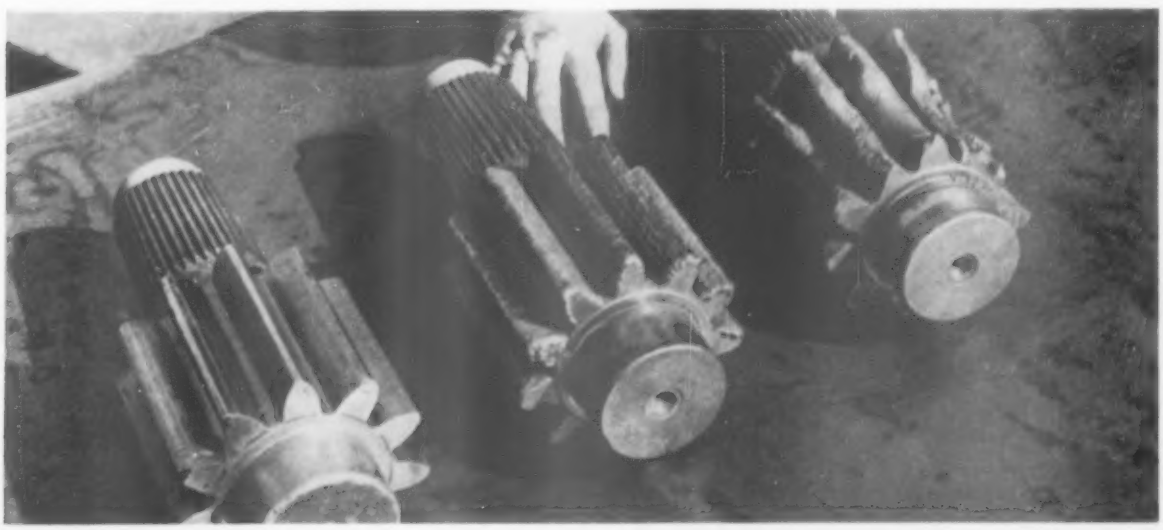


Fig. 14 Building up worn pinion gears, such as these, is a typical application for the iron-powder, build-up type electrodes

Cutting of nozzle openings in tank-car domes

CONSTRICTED TUNGSTEN-ARC CUTTING OF ALUMINUM

Gas-shielded tungsten-arc cutting found to produce excellent quality cuts in aluminum, magnesium and copper. It can be used mechanically or manually in any position

BY G. W. OYLER, R. L. O'BRIEN AND J. MAIER, III

The ever-widening use of nonferrous metals, particularly aluminum, has emphasized the need for a cutting process which would be as useful to the nonferrous industry as oxygen cutting has been to carbon-steel fabricators. The recent introduction of a constricted tungsten-arc cutting process has made available to industry a flexible and reliable method for cutting nonferrous metals.

G. W. Oyler, R. L. O'Brien and J. Maier, III, are engineers with Development Laboratory, Linde Air Products Co., Newark, N. J.

Presented at 1956 AWS National Spring Meeting in Buffalo, N. Y., May 7 to 11.

Constricted tungsten-arc cutting is a new, high-speed process which promises to be a valuable production tool for the aluminum industry. In this process, a highly constricted arc is used in conjunction with a mixture of argon and hydrogen gas to produce cuts of saw-like quality. Aluminum up to $1^1/_2$ in. thick can be cut with this process. In this paper, discussion centers on the basic theory of the process, the equipment requirements, the metallurgical effects of cutting and actual process applications.

The significance of constricted tungsten-arc cutting can best be viewed against the background of other nonferrous metal-cutting methods. In this respect, nonferrous metals are, for the most part, severed mechanically. This is now largely done either with shears or with band saws. In operations where shears or saws cannot be used, it is necessary to resort to drilling or chipping.

Other arc-cutting methods can be used to sever aluminum, although they have proved to be of limited value. As an example, it is possible to utilize carbon-arc and inert-gas tungsten-arc welding equipment for severing purposes. However, the use of this equipment is generally impractical to the extent that severing speeds are slow, kerf walls are ragged, and a limit is placed on the plate thicknesses which can be severed. The inert-gas consumable-electrode process has also been adapted to cutting, but this process has certain disadvantages which are not encountered in tungsten-arc cutting. For example, the consumable-electrode cutting process requires a supply of wire fed continuously into the arc at a very high speed, and extremely high currents are needed to burn off this wire and make the cut. Furthermore, the consumable-electrode cutting process can be applied only to limited plate thicknesses and is much slower than constricted tungsten-arc cutting.

Mechanical methods for severing nonferrous metals, particularly aluminum, generally produce high-quality cuts. Similarly, constricted tungsten-arc cutting produces high-quality kerf walls *but at much faster speeds.* This is illustrated in Fig. 1, which compares tungsten-arc cutting speeds to net speeds obtained with mechanical severing methods. The data shown represent the experiences of two tank-car fabricators during production-cutting operations on $^5/_8$-in. thick aluminum plate.

Basic Theory

Tungsten-arc cutting employs a constricted arc between a tungsten electrode and the workpiece, in conjunction with a high-velocity gas stream. The arc is concentrated and localized upon a small area of the base plate; its intense heat melts the metal. The gas, which is preheated by the arc, expands greatly and is forced through the constricting orifice. The molten metal is then continuously removed by the jet-like action of the gas stream to form a kerf. The cutting gas also protects the kerf walls from oxidation. The combined heat and force of the arc stream give a high-quality, saw-like cut, free of dross.

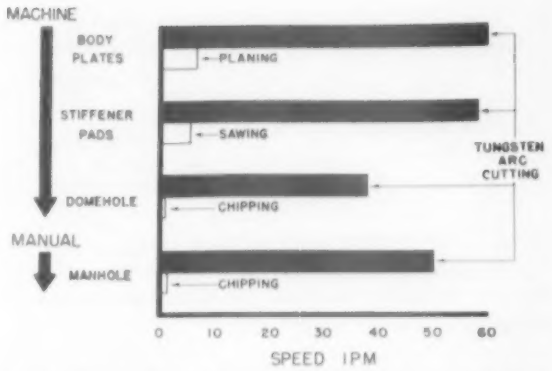


Fig. 1 Comparison of tungsten-arc cutting speeds in tank fabrication with speeds obtained using chipping hammers, saws and planers

Fig. 2 View of arc during trim-cutting of 1-in. thick aluminum

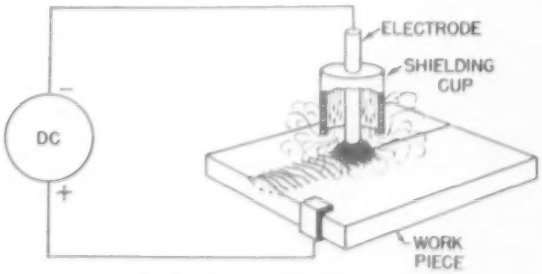


Fig. 3 Schematic diagram of tungsten-arc welding

Figure 2 shows the arc during trim cutting on 1-in. thick aluminum plate. The shape of the arc during metal removal is clearly indicated. Cutting with this process depends upon thermal action and not a combination of chemical and thermal action such as in the oxygen cutting of steel. Consequently, it can be used to sever any metal.

As shown schematically in Figs. 3 and 4, the basic

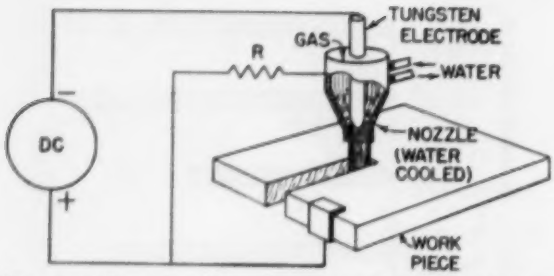


Fig. 4 Schematic diagram of constricted tungsten-arc cutting

tungsten-arc welding circuit, Fig. 3, is modified, as shown in Fig. 4, by the addition of a pilot-arc circuit to facilitate starting the cutting arc. The pilot-arc circuit connects the shielding cup or nozzle to the ground side of the power supply through a current-limiting resistor. Also, the inner diameter of the shielding cup is reduced to approximately $^1/_8$ in. to constrict the arc physically and to intensify it. The highly constricted arc, which is initiated by a high-frequency spark in conjunction with the pilot-arc circuit, provides the intense and concentrated heat for the cutting action. Water-cooling is necessary to prolong the life of the nozzle.

Equipment

Control and Torches

There are two types of torches and automatic cutting controls. One type is designed for manual cutting where the torch is hand-guided across the surface to be cut. The manual control and torch are pictured in Fig. 5. The other type is for a mechanized cutting unit mounted on an automatic travel mechanism. For manual cutting, separate supplies of argon and hydrogen gas are required so that a pilot arc can be established in a pure argon atmosphere. After the cutting arc has been established, hydrogen is automatically blended into the cutting gas stream. For mechanized cutting a premixed cylinder of argon and hydrogen gas is used. The manual cutting control differs chiefly from the mechanized control in that the former provides a means of mixing the two gases.

Both types of controls contain relays and solenoid valves to control the flow of cutting gas, to turn on and off the high-frequency power required only for arc-starting, to open and close the cutting power contactor, and to control the flow of cooling water. The machine control also provides a means of starting and stopping the carriage on which the cutting torch is mounted. A remote control box provided with the machine cutting control enables the operator to start the mechanized cutting operation and to stop it in case of an emergency.

The cutting torches include a collet to position the electrode in the copper orifice insert or nozzle. The manual cutting torches are designed with the head at a right angle to the torch handle, and the torch handle has been made 20 in. long so that operators familiar with oxygen-cutting apparatus can readily adapt to the new equipment. An insulated switch is located on the handle of the manual torch to enable the operator to start the pilot arc.

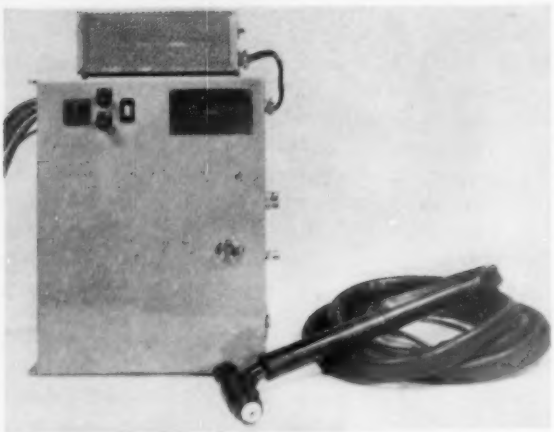


Fig. 5 Manual control and cutting torch

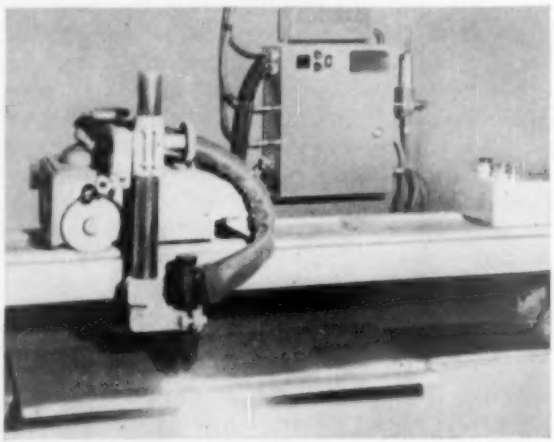


Fig. 6 Mechanized tungsten-arc cutting unit in operation

Tungsten electrodes similar to those used for inert-gas tungsten-arc welding are used in the cutting torches. Electrodes of $^1/_8$ in. diam are used for cutting the complete range of aluminum thicknesses for which the process is presently recommended—that is, up to $1^1/_2$ in. thick. The rate of electrode consumption is very low except when the current-carrying capacity of the electrode is exceeded.

Power Supplies

Because of the relatively high operating voltages required for this process, a power supply capable of providing 400 amp at 70 to 85 arc volts is necessary. Direct-current straight-polarity power is required. Motor-generators with a rated capacity of 600 amp and an open-circuit voltage of approximately 100 volts have proved satisfactory for all applications. It is also possible to connect two rectifier-type power supplies in series to obtain the necessary operating voltage.

Standard safety precautions must be followed in working with this equipment. Since the electrode is

set back in the constricting orifice, the operator is fully protected under normal circumstances.

Accessories

A number of accessory items are required for this process. In order to obtain consistent arc starting, a high-frequency generator capable of delivering a strong spark is essential. The high-frequency unit is immediately de-energized upon initiation of the arc. A heavy-duty welding contactor is also required to control the cutting power unless a primary contactor or a field-interruption relay is used on the power supply.

For mechanized cutting operations, an automatic carriage of the type commonly used for mechanized oxygen cutting is required. Figure 6 shows a machine torch mounted on a standard carriage. It is necessary to increase the normal carriage speeds to utilize the cutting speeds obtainable with this process.

Gas pressure regulators are used in conjunction with flowmeters to measure the supply of cutting gas. Special flowmeters have been calibrated for convenience in regulating the flow of hydrogen and the argon-hydrogen gas mixture used for this process.

Process Description

Cutting Gas Investigation

Two different mixtures of argon and hydrogen are used with this process: 65% argon and 35% hydrogen for machine cutting; 80% argon and 20% hydrogen for manual cutting. The decision to use these mixtures was made after a thorough investigation of many potentially useful gases. The investigation was conducted using a power supply with an open-circuit voltage of 100 volts. When a hydrogen content greater than 35% was used in combination with argon for machine cutting, a limitation was placed on the nozzle-to-work distance and arc starting was unreliable. The lower hydrogen content mixture is recommended for manual cutting to provide the operator with a greater latitude of arc length. For best cutting results, this length should be $^1/_4$ in. When a gas mixture with a hydrogen content greater than 20% is used for manual cutting, the arc is extinguished if the operator inadvertently increases the nozzle-to-work distance above $^3/_4$ in.

Argon is used in these gas mixtures because of its inertness and the relative ease of establishing an arc in an argon atmosphere. Hydrogen is used because it yields a high arc voltage as a result of its high resistance. Increased arc voltages are desirable because they produce greater heat at a given current for localized melting of the workpiece. Because of its lightness, hydrogen is accelerated to extremely high velocities as it is expanded in the heat of the arc and forced through the nozzle orifice. The high-velocity gas jet is used to remove the molten metal from the kerf.

Separate supplies of argon and hydrogen are used in manual cutting. The first step in the manual cutting operation is the establishment of a pilot arc between the electrode and the copper nozzle in an argon atmosphere. This pilot arc, which draws from 15 to 30 amp, provides illumination for the operator to locate the starting point of the cut with his shield in position. When the torch is brought within a half-inch of the work, the cutting arc is established on the workpiece. At the same time, a solenoid valve automatically opens to blend a predetermined amount of hydrogen into the cutting gas stream to give the recommended 80% argon and 20% hydrogen mixture.

For mechanized cutting, the torch is positioned over the starting point of the cut; and the momentary high-frequency spark, in conjunction with the pilot-arc circuit, initiates the cutting arc in the argon-hydrogen gas mixture. A cylinder containing the recommended mixture of 65% argon and 35% hydrogen gas is employed.

Current Capacity of Nozzles

Two sizes of orifice inserts or nozzles are available for use on the cutting torches, depending on the level of the cutting current employed. A $^1/_8$-in. diam orifice insert is used for cutting thin stock and has a maximum current capacity of 250 amp. A $^5/_{32}$-in. diam orifice insert, which has a maximum current capacity of 400 amp, is used for cutting heavy plate.

The limiting factor in the current capacity of the orifices is a phenomenon known as "double-arcing." Double-arcing occurs when two separate arcs are formed, one from the electrode to the nozzle and the other from the nozzle to the workpiece. If currents in excess of the orifice capacity are employed, the path of least resistance to the workpiece may be through the metallic nozzle rather than through the gas stream. Double-arcing damages and may destroy the nozzle. The torch is constructed in such a manner that if the nozzle insert is damaged, it can be easily and cheaply replaced. Optimum cutting results are obtained when the electrode is centered in the orifice. If the electrode is off center, the danger of double-arcing is increased and cut quality is reduced because the symmetry of the cutting gas pattern is destroyed.

Arc Starting

A high-frequency spark is utilized for arc starting with both the manual and machine torches. With the manual torch, the high-frequency spark leads the pilot arc from the electrode to the nozzle. The pilot arc, which is stable in argon, is then utilized to start the cutting arc. In mechanized cutting operations, there is no separately discernible pilot arc. Since the torch is always positioned directly over the work, the pilot arc and cutting arc are started simultaneously. In the case of both manual and machine torches, the high-frequency power is automatically turned off as soon as the pilot arc is established.

Cut Quality

Cuts of saw-like quality as illustrated in Fig. 7 may be obtained with this process. A cross-sectional view of the kerf obtained using maximum cutting speed will show a slightly greater width at the top than at the bottom. The torch can be angled to produce one vertical side, or slower cutting speeds with equivalent

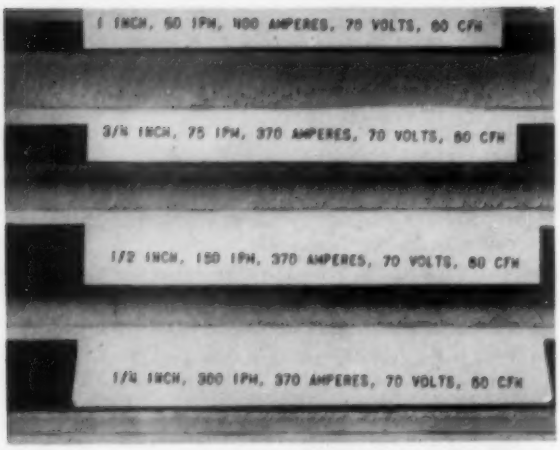

1 INCH, 50 IPM, 400 AMPERES, 70 VOLTS, 80 CFH
3/4 INCH, 75 IPM, 370 AMPERES, 70 VOLTS, 80 CFH
1/2 INCH, 150 IPM, 370 AMPERES, 70 VOLTS, 80 CFH
1/4 INCH, 300 IPM, 370 AMPERES, 70 VOLTS, 80 CFH

Fig. 7 Samples showing cut quality

power input can be used to make the kerf walls parallel.

Procedure

Manual Cutting

In manual cutting, the control is ready for use as soon as the main line switch is turned on: no warm-up period is necessary. The power supply should be set and gas flows adjusted. The pilot arc is then established by pressing the torch switch. The torch switch opens the water and argon solenoid valves, closes the contactor, and energizes the high-frequency generator. A high-frequency spark is used to start the pilot arc which is then self-maintaining in an argon atmosphere.

Having established the pilot arc, the operator, with his helmet in position, locates the starting point of the cut with illumination provided by the pilot arc. A No. 8 filter glass in the operator's shield will provide adequate protection from the arc glare. The end of the torch should be about 1 in. away from the plate at this time. The operator then brings the torch closer to the work, and, when the nozzle is approximately $^1/_2$ in. from the workpiece, the cutting arc will be established on the work. As soon as the cutting arc is established, the hydrogen solenoid valve blends a predetermined amount of hydrogen into the gas stream and a hold-in circuit takes over the control so that the operator may release the torch switch. The operator then makes the cut, being careful to maintain a nozzle-to-work distance of approximately $^1/_4$ in. At the end of the cut, the arc loses its ground and is extinguished. The circuit is automatically de-energized, the gas solenoid valves close, and the main contactor opens. The control is then ready for the next operation. The arc may also be broken during the cut by pulling the torch away from the work.

Mechanized Cutting

For mechanized cutting, the torch is located so that the center of the orifice is approximately $^1/_4$ in. above the edge of the plate to be cut. The work should be relatively flat or parallel with the carriage track. The cutting arc is established by pressing the start button on the remote control box. The start button energizes the main contactor, the high-frequency generator, and the gas solenoid valve. The high-frequency generator comes on just long enough to initiate the arc and is then de-energized. Although the machine cutting torch has no separately discernible pilot arc as does the hand torch, the pilot-arc circuit is necessary to start the cutting arc in the argon-hydrogen atmosphere. As soon as the cutting arc is established, a hold-in circuit permits the operator to release the start button and the carriage is automatically put in motion. At the end of the cut, the arc is extinguished for lack of a ground and the hold-in circuit is de-energized; the gas solenoid valve closes and the main contactor opens. The control is then ready for the next operation.

Process Uses

Scope

Constricted tungsten-arc cutting can be utilized to cut aluminum in the same manner and for the same purposes that oxygen cutting is used on steel. All operations can be performed either manually or mechanically. In addition to straight-line cutting, this new process can also be used for shape-cutting.

Cutting can be accomplished in all positions with equal ease. Cutting in the overhead position is illustrated in Fig. 8. Beveling can be accomplished by angling the torch as desired. Any type of bevel can be made as shown in Fig. 9. The double bevel shown in this photograph was made in a two-pass operation while the single bevels were made in one pass. Stack-cutting can be accomplished by firmly clamping the sheets together much the same as in oxygen cutting. Figure 10 illustrates the quality that can be obtained in the cutting of eight $^1/_8$-in. thick sheets or four $^1/_4$-in. thick sheets. Trim cuts as shallow as $^1/_{32}$ in. are also possible. It is not necessary to start the cut at the

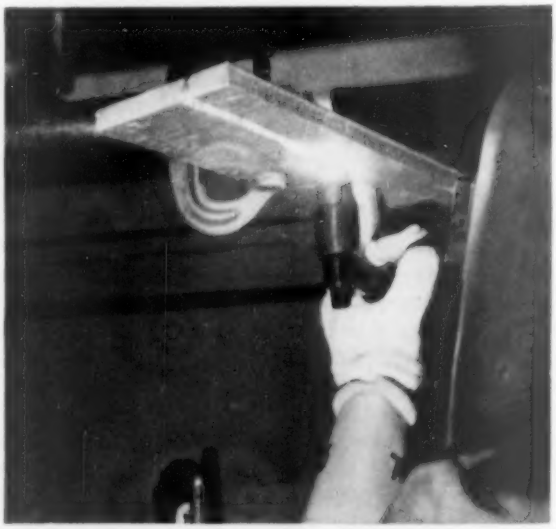


Fig. 8 Cutting in the overhead position

edge of the plate since any thickness of plate that can be cut can also be pierced.

Gouging can be effectively accomplished by angling the torch to approximately 50 deg in the direction of travel. Single-pass or multiple-pass gouging may be employed as desired.

Operating Data

Operating data presented in tabulated form in Tables 1 and 2 indicate conditions for making good quality cuts in aluminum. The current levels listed in these tables are not critical. Higher currents than are necessary to cut the respective thicknesses can be used but are not recommended because of the possible occurrence of double-arcing and increased heat build-up in the plate. If currents lower than necessary to cut the plate are used, gouging will result. Thus, the listed amperage levels are optimum.

Higher speeds than those presented in the table have been obtained. Good quality cuts were made in $^1/_4$-in. thick plate at 600 ipm and in $^1/_8$-in. thick plate at 800 ipm using two 400-amp rectifiers connected in series. Even faster cutting speeds can be attained by using larger power supplies.

Cutting Other Metals

Data have been determined for the cutting of magnesium up to $1^1/_2$ in. thick and copper up to 1 in. thick. The cutting speeds obtainable on magnesium are greater than for an equal thickness of aluminum because magnesium has a lower heat conductivity and lower density. The cutting speed for a given thickness of copper is less than for the same thickness of aluminum because copper has a higher density, greater heat conductivity and a higher melting point.

It is possible to cut other metals such as stainless steel and nickel with this process. The resulting kerf walls are of high quality, but a certain amount of dross tends to adhere to the bottom edge of the cut.

Metallurgical Effects of Tungsten-Arc Cutting

The depth of the heat-affected zone is approximately the same for $^1/_4$-in. to $1^1/_2$-in. thick plates providing that maximum cutting speeds are used for a given power input. Photomicrographs of cross-sectioned plates clearly show that the melted and resolidified area extends to a maximum depth of 0.040 in. This heat-affected area has a typically cast structure of minute grain size even much finer than ASTM grain size No. 8 for steel. No intergranular melting was observed beyond the resolidified zone. Thus, the heat-affected zone according to microscopic examination, as shown in Fig. 11, is limited to the depth of this fine-grained zone. Hardness readings indicate that the approximate normal hardness of the plate is realized beyond a depth of 0.064 in.

Welds were made using both the consumable-elec-

Table 1—Manual Cutting Conditions

Plate thickness, in.	*Cutting speed, ipm*	*Arc voltage, volts*	*current, amps*	*Gas* flow, cfh*
$^1/_4$	60	50	200	50
$^1/_2$	40	60	280	60
$^3/_4$	25	65	300	70
1	20	68	330	70
$1^1/_4$	20	73	350	70
$1^1/_2$	15	76	360	70

* 80% argon, 20% hydrogen.

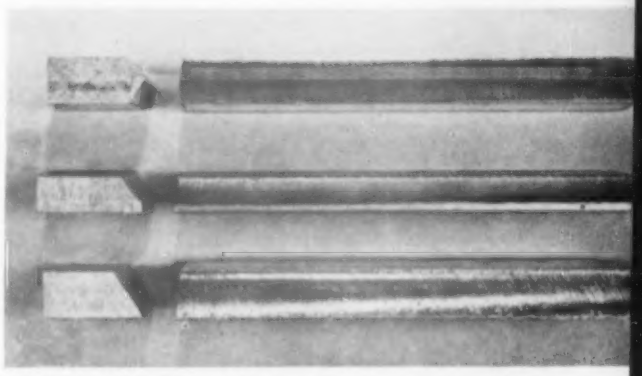


Fig. 9 Examples of bevel cuts used in plate edge preparation

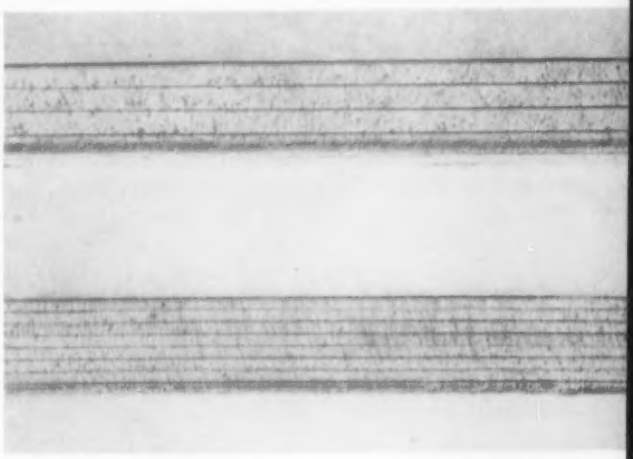


Fig. 10 Stack-cutting of aluminum: four $^1/_4$-in. and eight $^1/_8$-in. thick sheets

Table 2—Mechanized Cutting Conditions

Plate thickness, in.	*Cutting speed, ipm*	*Arc voltage, volts*	*Current, amps*	*Gas* flow, cfh*
$^1/_4$	100	62	240	50
$^1/_4$	300	70	380	60
$^1/_2$	75	62	280	60
$^1/_2$	150	65	400	60
$^3/_4$	45	70	280	60
$^3/_4$	75	70	350	60
1	35	70	330	60
1	50	72	400	60
$1^1/_4$	20	74	330	70
$1^1/_4$	50	74	400	70
$1^1/_2$	20	76	360	70
$1^1/_2$	35	80	400	70

* 65% argon, 35% hydrogen.

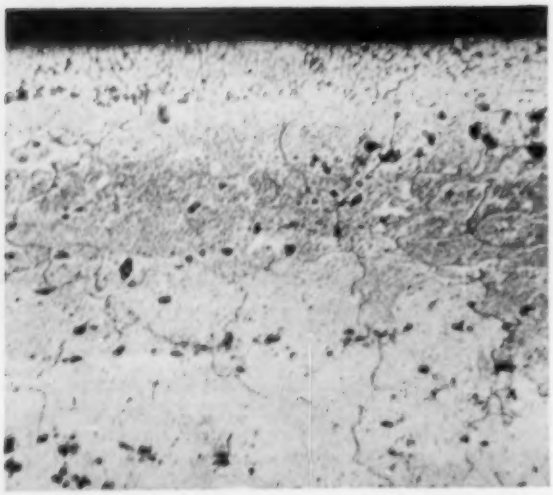


Fig. 11 Photomicrograph showing the depth of the heat-affected zone in 2024-T4 plate (X200)

trode and nonconsumable-electrode processes on several different thicknesses of plate of various alloys which had been cut with this process. Duplicate welds were then made in plate which had been saw-cut and etched after sawing. Radiographic examination showed no difference in weld soundness attributable to the method of preparation. Examination of physical properties, which included tensile, guided-bend and free-bend tests also showed that arc-cut edges are equivalent to the saw-cut edges.

Industrial Applications

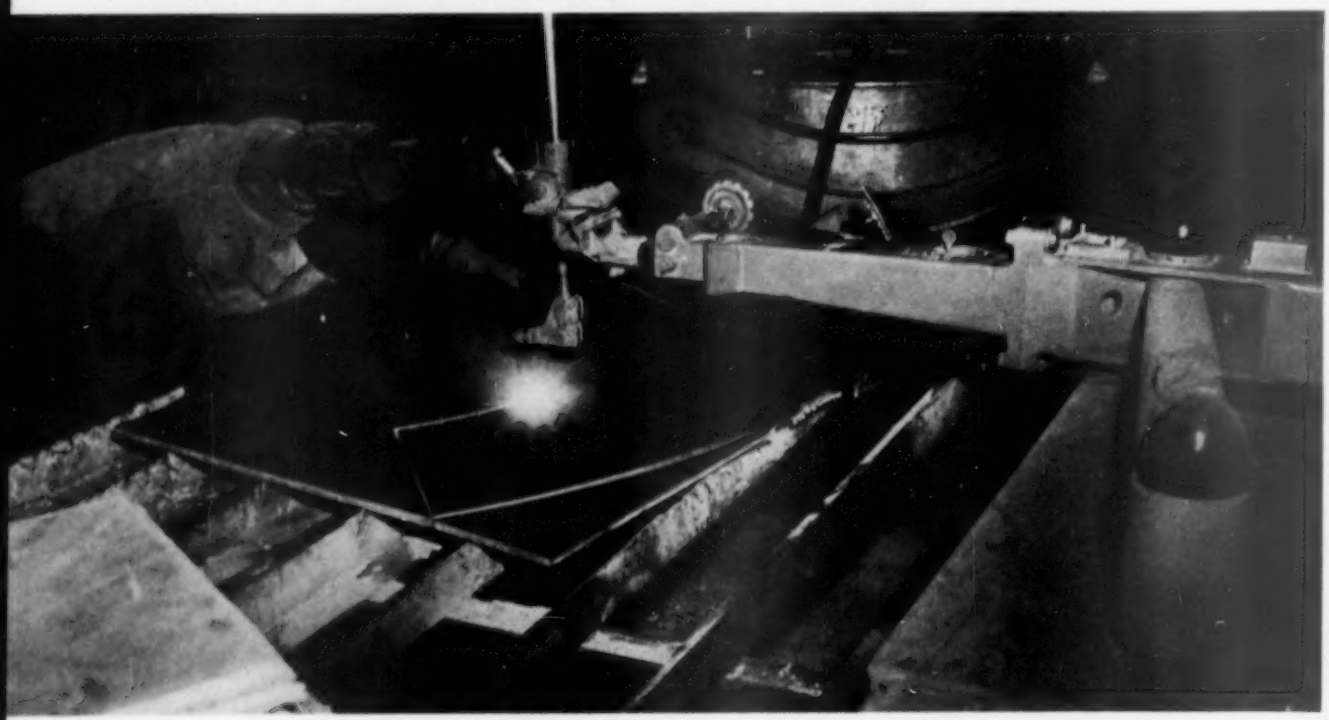
Constricted tungsten-arc cutting has potential in all fields of nonferrous metal fabrication. At present, the full benefits of the process can be obtained through its use in aluminum fabrication. The net result of using this process is increased production with excellent cut quality. The process is recommended for use in the manufacture of automotive and railroad components as well as for the fabrication of structural shapes or equipment for chemical processing, heating and refrigeration.

This process is now being used primarily in the aircraft industry, in shipyards and for tank fabrication. The lead photograph and Figs. 12 and 13 show actual production setups as the process was applied to $^5/_8$-in. thick aluminum plate in a tank fabrication shop. (The actual speeds of operation used in this shop are incorporated in Fig. 1.)

Referring to the lead photograph at the beginning of this article, an operator is shown using a manual tungsten-arc cutting torch to cut out a manhole in the dome for a tank car. Controls for the torch are shown in the background along with gas cylinders, a high-frequency unit, and a recirculating system for cooling water. These items are mounted on a frame which stands on casters and can be rolled to different work locations.

Figure 12 shows one of two different mechanized tungsten-arc cutting operations in the fabrication of tank-car stiffener pads. In this figure, the torch is mounted on a standard shape cutting machine. As

Fig. 12 Application of tungsten-arc process for the shape-cutting of a stiffener pad in tank-car fabrication



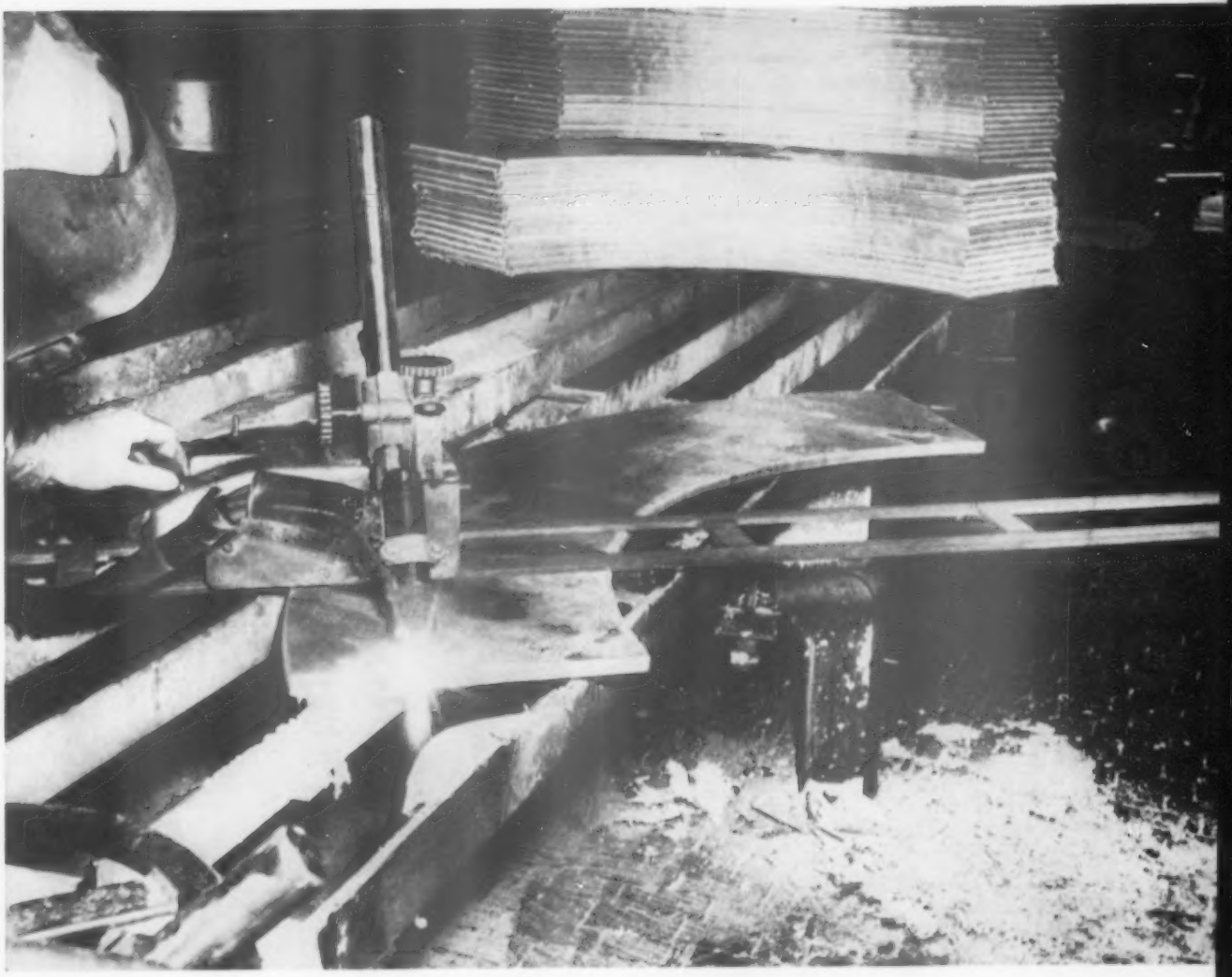


Fig. 13 Bevel cutting of stiffener pads prior to welding

can be seen, sharp corners can easily be made with the tungsten-arc torch.

The second mechanized tungsten-arc cutting operation in the fabrication of stiffener pads is shown in Fig. 13. In this instance, the torch is mounted on a standard straight-line cutting machine and is being used to bevel the edge of a stiffener pad prior to a subsequent welding operation. Shape-cut pads are piled in the background. Dross from the cutting operation is on the shop floor in the form of a conglomerate which can be easily picked up in one piece for discard as scrap.

Calculating the cost of labor, overhead and consumables on an actual production basis, the cost of chipping holes in the tank and dome was 26 times that of manual tungsten-arc cutting for the same holes. In the edge preparation of stiffener pads, the cost of sawing was 6 times greater than the cost of mechanized tungsten-arc cutting.

Summary

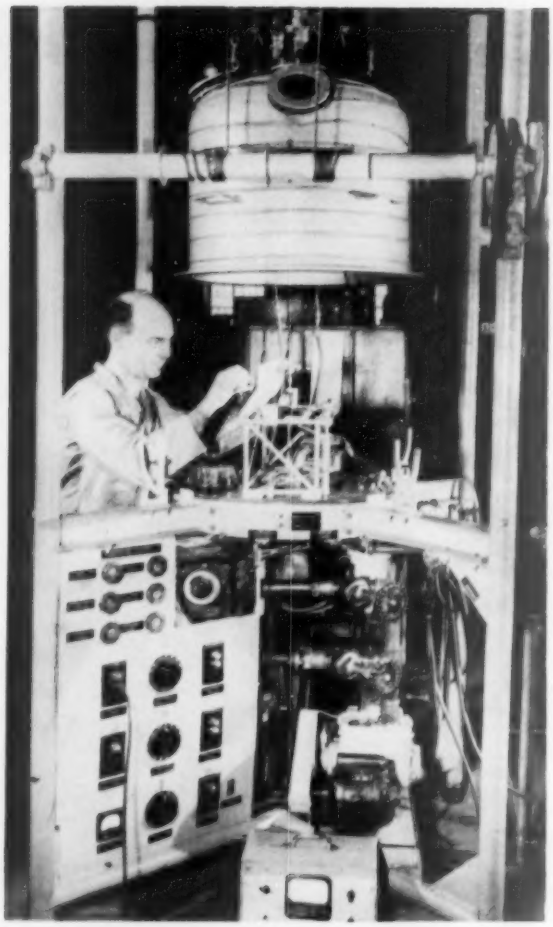
At present, constricted tungsten-arc cutting produces excellent quality cuts in aluminum, magnesium and copper. A direct-current power source with a minimum open-circuit voltage of approximately 100 volts is required for successful operation of the process. Separate controls and torches are used for manual and mechanized cutting. A gas mixture consisting of 65% argon and 35% hydrogen is recommended for machine cutting. A mixture of 80% argon and 20% hydrogen is used for manual cutting. The intense heat of the constricted tungsten arc melts the metal and the molten metal is then mechanically removed by the gas stream.

Constricted tungsten-arc cutting can be used mechanically or manually in any position for cutting straight lines, bevels, circles and shapes. Cutting speeds obtained with this process are many times faster than speeds attained with other severing methods.

Arc welding in an inert-atmosphere chamber found to be a satisfactory method for small molybdenum tube-to-header heat exchangers, despite the brittleness of the resulting welds

WELDING OF MOLYBDENUM HEAT EXCHANGERS

BY R. E. MONROE AND D. C. MARTIN



Loading simulated heat exchangers in welding chamber

ABSTRACT. The feasibility of producing complex welded components in currently available arc-cast molybdenum was demonstrated by the construction of simulated heat exchangers. Assemblies containing 52 tubes welded into a header sheet were completed without any failures occurring as a result of room-temperature brittleness of the welds. Identical welds were not always obtained because of factors which are apparently associated with the cone-arc welding process. The arc column does not appear to rotate as suggested in the original cone-arc theory.

Introduction

Small tube-to-header heat exchangers have been developed in recent years for the handling of highly corrosive fluids at elevated temperatures. The design of these heat exchangers requires welding many small tubes into header sheets with leak-tight and uniform welds. Molybdenum, with its excellent high-temperature strength and corrosion resistance in certain fluids would be a good construction material for such heat exchangers, but room-temperature brittleness in molybdenum weldments made it a doubtful choice for such a use. An experimental program was conducted during 1954 to determine if simulated heat exchangers could be fabricated from molybdenum using the cone-arc process. Aside from the usual considerations, molybdenum had to be welded in an inert-atmosphere chamber to prevent oxidation, and the weld and heat-affected zones of the molybdenum were expected to be brittle at room temperature. More recent investigations,[1] have shown that good room-temperature ductility can be obtained in molybdenum weldments, but the materials used in this program had poor weldment ductility.

Welding conditions were established with single-tube specimens welded in air with inert-gas shielding. From this point, work progressed to multitube specimens containing 5, 19 and 52 tubes. A special atmosphere chamber with remote controls for positioning the specimens was built for this work. Some difficulty was had throughout the test program with inconsistent results.

R. E. Monroe is Principal Welding Engineer and **D. C. Martin** is Consultant, Metals Joining Research Division, Battelle Memorial Institute, Columbus, Ohio.

Since many of these things seem to be related to the welding process and equipment, the sections of this paper dealing with these items are somewhat longer than is usual.

Ultimately, it was possible to weld 52-tube assemblies which were free of porosity and cracks. These welds were made with direct-current and shrink-fit joints. Since welding conditions appeared to be dependent on assembly design, no further experimental work has been planned. However, the feasibility of producing complex welded assemblies with commercial molybdenum has been demonstrated.

Materials

Unalloyed carbon-deoxidized arc-cast molybdenum containing 0.056 w/o carbon was used for the header sheets and tubing which formed the simulated heat exchangers. This type of molybdenum is low in oxygen content and has a minimum tendency for porosity and crack formation in arc welds. Headers were machined from $^1/_{16}$-in. thick sheet. The initial supply of tubing was made by machining tube sections from rod. Later, a small supply of extruded tubing was obtained. All tests with multitube specimens were made with 0.156-in. OD by 0.015-in. wall tubing. Some preliminary tests were made with powder-metallurgy molybdenum sheet and tubing because of its availability.

The carbon content of the molybdenum used in this work was about 3 times as high as the present value for commercial molybdenum.

Equipment

The cone-arc process[2] was suggested as a means of making uniform circular welds by utilizing the motor effect to deflect the ion beam. It was theorized that, under the proper conditions, the arc column can be made to rotate at a very high speed around the periphery of a tube-to-header joint, producing a uniform weld. The process has been evaluated and successfully used to fabricate small stainless steel and Inconel heat exchangers by other experimenters.[3] Standard commercial parts for tungsten-arc welding were found to be satisfactory for use in performing cone-arc welding operations in air. As will be explained later, there is reason to doubt the correctness of the cone-arc theory as it was originally presented, and the process is no longer used.

Welding Circuit

Experiments were conducted with direct- and alternating-current power sources. A 400-amp rectifier welder with a built-in electronic timer was used as the direct-current power source. A 200-amp balanced-wave transformer was used as the alternating-current power source. A mechanical timer was used in conjunction with the alternating-current source. Both power units were equipped with high-frequency arc starters and stabilizers. Timers were connected to operate only during actual arc time. The control and power circuits performed satisfactorily during this investigation.

Welding Chamber

A special welding chamber, shown in Fig. 1, was designed and built for use in this work. The chamber was designed to provide a high-purity atmosphere by vacuum purging at 0.1 micron of mercury before admitting an inert-gas atmosphere.

Essentially, the chamber consisted of a nickel-plated steel bell jar supported on a flat base plate. Two Kinney CVM 3534 pumps were used for roughing and backing an MC-275 diffusion pump during purging. A tungsten-electrode holder with a vertical adjustment device was set in the top of the bell jar. This holder was fitted with a commercially available magnetic nozzle and an AWS EWZr electrode. Specimens were held in a copper jig block attached to a positioning table. The table was oriented by a control rod passing through a Wilson seal in the side of the bell jar. Three movements were available to position the specimens under the electrode: rotation about the center, translation, and partial rotation pivoted at the seal. Each joint was centered under the electrode by lowering the electrode into the tube.

Four infrared lamps were used to preheat the specimens and jig block to the desired prewelding temperature. Temperature was measured with a thermocouple and a controller.

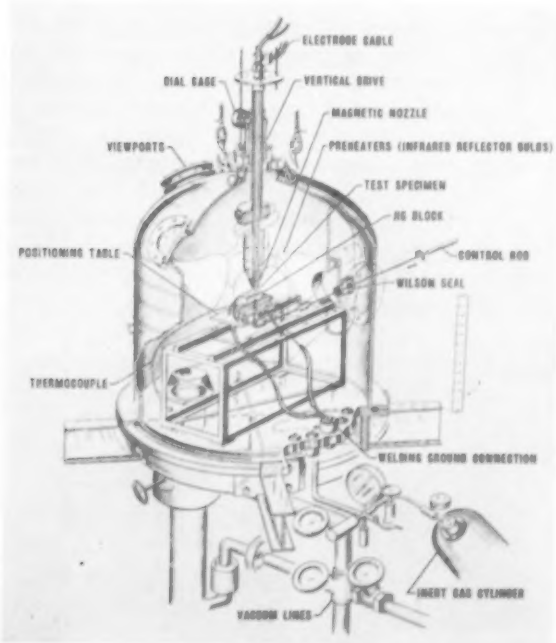


Fig. 1 Cut-away sketch of welding chamber

Experimental Results

The results of many preliminary tube-to-header joint tests made in air with argon shielding were very promising. All of these tests were made on specimens containing a single tube centered in a header sheet $^1/_2$ in. square. Acceptable welds could be made over

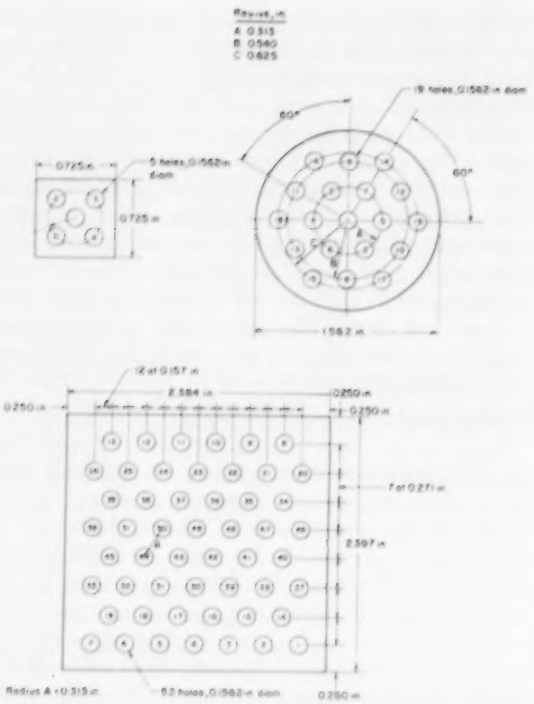


Fig. 2 Design of header sheets for 5-, 19- and 52-tube specimens

a wide range of conditions, but a short welding cycle was used to minimize contamination of the molybdenum. Arc time, current, arc gap, electrode shape, and arc angle could be changed between broad maximum and minimum limits with little or no effect on the shape of the resulting welds. The area of the tube opening at the welds could be maintained nearer the original tube opening by recessing the tube a distance equal to the wall thickness.

Tests in the welding chamber were confined to 5-, 19- and 52-tube specimens. The design of header sheets for these specimens is shown in Fig. 2. The hole spacing used on the 19- and 52-tube specimens was arbitrarily set at two-hole diameters. A smaller spacing could be used satisfactorily. The edge allowance on the outer holes of the 52-tube headers was increased, since the outer welds on 19-tube headers were always eccentric near the edge. Some distortion of the header sheet occurred when welding 52-tube specimens. The welding sequence shown in Fig. 2 was adopted to minimize this effect.

Throughout the work on multitube specimens, it was very difficult to obtain specimens containing all good welds. No difficulty was encountered from cracking or porosity, but test results were continually plagued by small inconsistencies. Welds seemed to be off-center and, in some cases, unwelded on one side of the tube. Unfortunately, no set pattern was observed and various possible causes had to be investigated as discussed below.

1. Positioning. The exact centering of the electrode in line with the tube was not possible with the original equipment. With redesigned equipment, concentricity could be maintained within 0.001 in. Some improvement in weld quality was obtained with the improved electrode alignment, but occasional bad welds still persisted.

2. Gas Expansion. A difference in the welding behavior of open tubes versus closed tubes was noted and was attributed to expansion of the inert gas trapped in closed-end tubes. Satisfactory welds could be made in either type tube, but adjustments for the tube type had to be made. Occasionally, bad welds occurred with both types of tube.

The effect of gas expansion might become troublesome in the welding of actual heat exchangers, since the length of tubing may vary from one tube to another, and restrictions in the tubing may be placed at varying distances from the weld. Gas blowing back out of closed-end tubes tended to prevent filling of the tube. This effect might be used to advantage in some applications by blowing inert gas back through the tube during the making of the welds.

3. Electrode Size and Shape. Most of this welding work was conducted with an electrode of the same diameter as the ID of the tubing. No marked differences in results were noted in using electrodes larger or smaller than this diameter. Bad welds could not be eliminated by changing the size or shape of the electrode.

4. Arc Phenomena. The effects of arc phenomena were perhaps the most difficult factors to evaluate since they depend upon many other variables. Inconsistencies noticed in welding multitube headers were strongly suggestive of arc blow. Normally, arc blow is corrected by relocation of the ground connection or by the use of a magnetic nozzle to concentrate the arc. The ground connection to the copper jig block was made as uniform as possible, giving some improvement. However, the current path from the jig block to the header sheet still may have varied because of point contact. Since a magnetic nozzle was already in use, it must be assumed that the magnetic field was not strong enough to exert the required force on the arc. During the investigation of arc phenomena, high-speed motion pictures of the arc were taken at 3000 frames per second. The arc column could not be observed rotating but appeared merely as a cone.

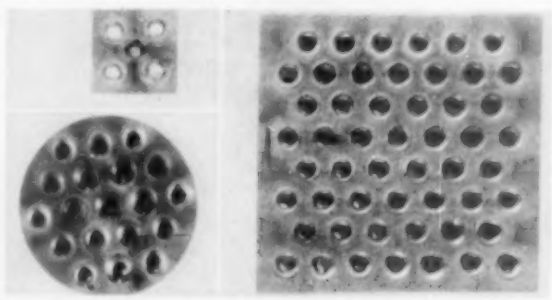


Fig. 3 Typical welded molybdenum headers

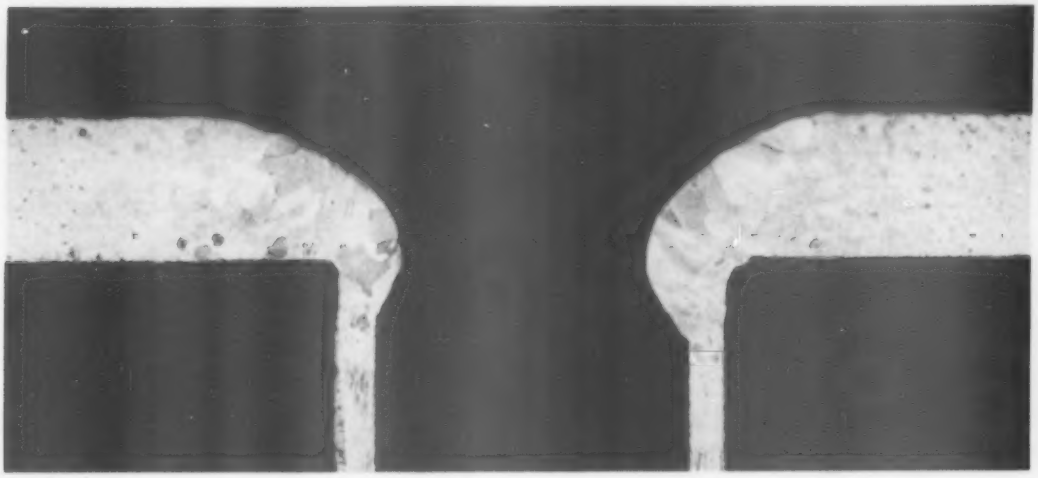


Fig. 4 *Transverse section of molybdenum tube-to-header joint*

Melting of the tube periphery could be observed in these films and appeared to progress uniformly in one direction with both an alternating-current or direct-current arc.

5. Power Source. Since alternating current is not so susceptible to arc-blow phenomena as direct current, it was used in a number of tests. Some improvement was noted in that the welds were more uniform in diameter. However, because of the change in heat balance, it was difficult to prevent melting of the electrode tip and the resultant contamination of the weld metal. Even the use of a large-diameter electrode was not effective in overcoming this difficulty and tests with alternating current were discontinued.

6. Machine Characteristics. An oscilloscope was used to show the wave form for current and voltage with the direct-current power source to determine if the machine output was erratic. No unusual changes in the wave shapes which would account for bad welds when using this equipment were noted.

7. Joint Fit. The usual practice followed in assembly of test specimens was to use header sheets with drilled holes which were reamed to fit the individual tubes during assembly. This was necessary to allow for variations in the tube OD. This procedure gave an assembly in which the clearance between the tube and header sheet probably varied slightly from joint to joint. Several tests were made in which the tubes were shrunk to fit into the header sheet. Headers welded with this assembly technique were among the best produced. The same effect also was achieved by recessing the tubes a distance equal to the tube wall thickness. These tests seem to indicate that the production of uniform welds may be largely a function of uniform heat transfer.

The welding conditions given in Table 1 proved most satisfactory for the specimen designs used in this program. With these conditions, the tube opening at the weld was 90 per cent of the original tube area when using recessed tubes and 74 per cent of the original tube area when using flush tubes. Photographs of some typical welded headers are shown in Fig. 3. A transverse section of a typical weld is shown in Fig. 4.

Table 1—Conditions for Cone-Arc Welding Molybdenum

Power source	D-c rectifier
Arc current	200 amp
Arc voltage	18 v
Arc gap	0.040 in.
Arc time	0.5 sec
Atmosphere	Grade A helium
Electrode	$^1/_8$-in. AWS EWZr with long taper to $^1/_{16}$-in. radius tip
Preheat	400° F

Conclusions

Molybdenum can be used as a structural material for the construction of tube-and-header heat exchangers. Fusion welding is a satisfactory method of joining, despite the brittleness of the resulting welds. Improvement in the quality of the molybdenum components would simplify the fabrication techniques.

Experience with the cone-arc welding process does not appear to substantiate the basic theory of arc rotation. Uniform circumferential welds appear to be primarily dependent on uniform heat transfer.

Acknowledgments

The suggestions and help of C. B. Voldrich, N. E. Weare, W. H. Kearns, A. M. Thingulstad, and the late R. J. Crist during this investigation are greatly appreciated.

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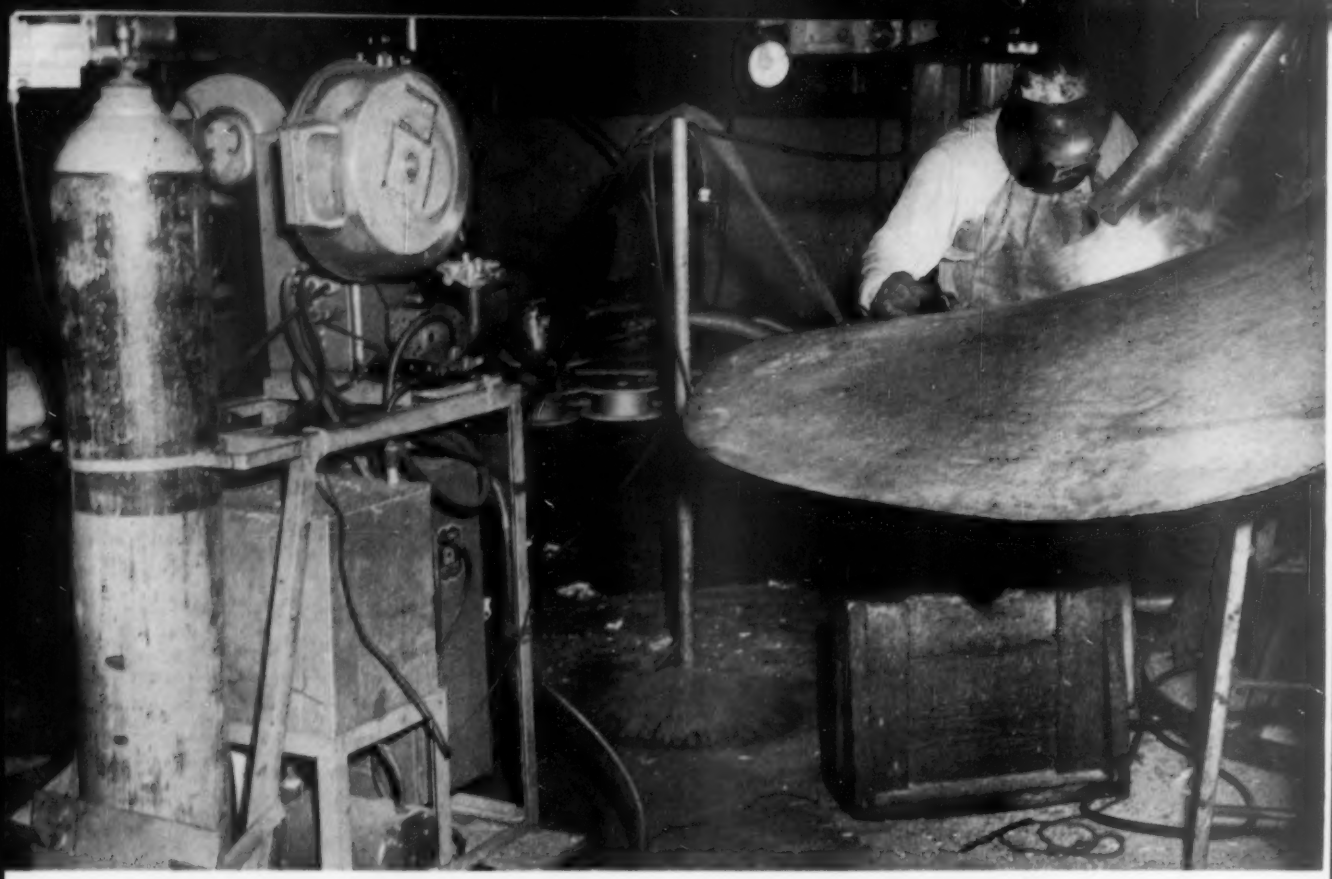

Inert-gas-shielded metal-arc welding of nickel-aluminum bronze propeller

WELDING OF NICKEL-ALUMINUM BRONZE

BY JOHN L. CAHILL

Aluminum-bronze filler metal found to have several advantages for the welding of nickel-aluminum bronze propellers

SYNOPSIS. The author discusses the welding of nickel-aluminum bronze using the inert-gas-shielded metal-arc process with both nickel-aluminum bronze and aluminum bronze filler wires. The latter is considered preferable at the present time but experimental work is proceeding with modifications of the nickel-aluminum bronze filler wire to get higher strengths in deposit.

John L. Cahill is Shipyard Welding Engineer, New York Naval Shipyard, Brooklyn, N. Y.

Introduction

For many years the Navy, as well as commercial shipping, have used a manganese-bronze alloy for propellers. Under the terms of the specification MIL-B-16443 governing this alloy, this material is basically a modified 60-40 brass with a minimum tensile strength of 65,000 psi. It also contains small amounts of aluminum, iron and manganese. The service record of this material is fairly good but it leaves much to be desired, particularly as to resistance to erosion, cavitation and dezincification. However, since such propellers are readily repaired by welding and are more easily worked than some of the alloys having better properties, the use of manganese bronze has been quite prevalent.

In recent years, a new alloy for propellers has come

into quite extensive use, particularly on tankers and similar vessels. The success encountered in their use, particularly in cold weather areas, such as the Arctic, indicate that this alloy may eventually supplant the manganese bronzes used to date. This alloy is a 5% nickel-aluminum bronze having an aluminum content of 9 to 10% and an iron content of about 5%. It is being cast successfully in both this country and in Europe under various trade names.

Since all propellers are subject to damage from various angles one of the first considerations in dealing with a new material for such use should be "How do we weld it?" So far as we could ascertain, little or no data are available on the properties of welds made in this nickel-aluminum bronze alloy. All available information is based upon metal-arc welding using coated electrodes of varying compositions with widely different operating conditions. For example, one source quoted preheat of 1400° F minimum using aluminum-bronze electrodes while another stated that welds were made with nickel-aluminum bronze electrodes with no preheat. Nothing was found relative to joint properties, weld efficiency, chemistry, etc. It appeared that we should possess more data along these lines and that any such data collected should be obtained under conditions of welding operation approximating those used in making major repairs to a propeller.

Background

We have a considerable amount of information on the properties of welds made in manganese-bronze castings using various welding processes including oxy-acetylene, shielded metal arc, carbon arc, and inert-gas-shielded metal arc. Filler metals employed have comprised manganese bronzes and aluminum bronzes. Satisfactory repairs have been made by these various processes and qualification test data have been obtained from a standardized test specimen which simulates a major repair to a propeller.

Welding with Nickel-Aluminum Bronze Filler Wire

In an attempt to obtain comparative data with the nickel-aluminum bronze alloy, we proceeded to make the same type of qualification test using the inert-gas-shielded metal-arc process. The filler wire was a nickel-aluminum bronze wire, $^3/_{32}$ in. in diameter (analysis is approximately $10^1/_2$% aluminum, 5% nickel and 5% iron). The details of welding are shown in Figure 1. There was no external preheat employed and the interpass temperature was that supplied by the welding process itself, (from 200 to 300° F). After twelve passes had been made on the top side, extensive distortion was noted (about 14° pull-up) and, in an effort to minimize this, the casting was turned over and the back side chipped out. Several passes were then deposited on the back side as noted in Fig. 1 when cracking of the entire length of weld was noticed. The test was terminated and macrosections were cut from the assembly. As may be noted, the weld-metal hardness was 302 Brinell as compared with

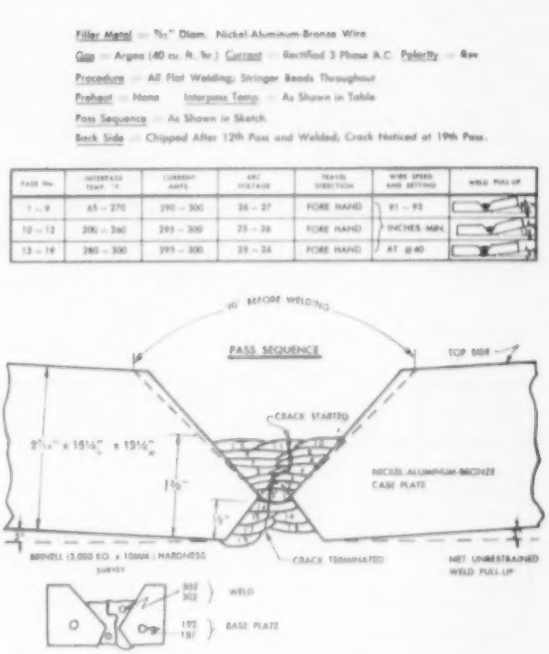
Filler Metal — Diam. Nickel Aluminum Bronze Wire
Gas — Argon (40 cu. ft. hr.) Current — Rectified 3 Phase A.C. Polarity — Rev
Procedure — All Flat Welding, Stringer Beads Throughout
Preheat — None Interpass Temp — As Shown in Table
Pass Sequence — As Shown in Sketch
Back Side — Chipped After 12th Pass and Welded; Crack Noticed at 19th Pass.
PASS SEQUENCE
TOP SIDE
CRACK STARTED
CRACK TERMINATED
NICKEL ALUMINUM BRONZE CAST PLATE
BASE PLATE
WELD

Fig. 1 Weld details: nickel-aluminum bronze filler wire; no preheat

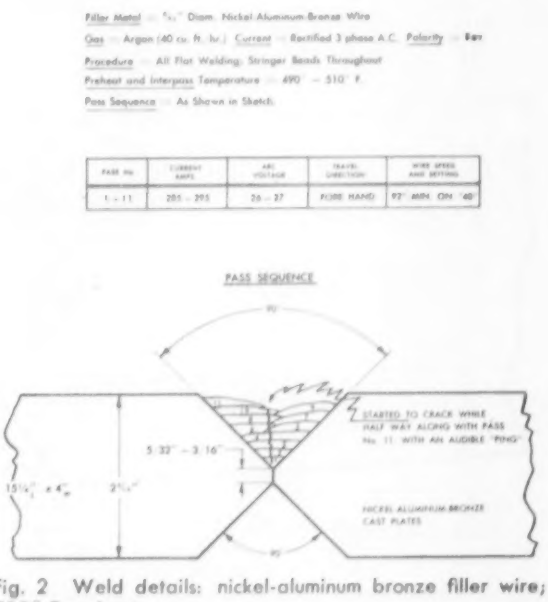
Filler Metal — Diam. Nickel Aluminum Bronze Wire
Gas — Argon (40 cu. ft. hr.) Current — Rectified 3 phase A.C. Polarity — Rev
Procedure — All Flat Welding, Stringer Beads Throughout
Preheat and Interpass Temperature — 490° — 510° F.
Pass Sequence — As Shown in Sketch.
PASS SEQUENCE
NICKEL ALUMINUM BRONZE CAST PLATES

Fig. 2 Weld details: nickel-aluminum bronze filler wire; 500° F preheat

192 in the base casting. This is extraordinarily hard for a bronze weld metal deposit.

In order to determine the effect, if any of normal preheats on this filler metal, a specimen was prepared using the sequence noted in Fig. 2. Despite a preheat and interpass temperature of approximately 500° F, this specimen also cracked during welding through the entire weld length. Further work with this nickel-aluminum bronze filler wire was discontinued.

Filler Metal = 5/64" Diam. Stranded Aluminum Bronze Wire

Gas = Argon (45 cu. ft./hr.) Current = Rectified 3 Phase A.C. Polarity = Rev.

Procedure = All Flat Welding; Stringer Beads Throughout

Preheat = None Interpass Temp. = As Shown in Table

Pass Sequence = As Shown in Sketch.

Back Side = Chipped After 15th Pass and Welded; Top Side Then Finished

Stress Relieving = None Total Arc Time = 98½ Min.

PASS No.	INTERPASS TEMP. °F.	CURRENT AMPS.	ARC VOLTAGE	TRAVEL DIRECTION	WIRE SPEED AND SETTING	WELD PULL-UP
1 – 15	70 – 300	265 – 275	26 – 27	FORE HAND	190 – 195	
16 – 27	125 – 320	270 –275	26 – 27	FORE HAND	INCHES/MIN.	
28 – 62	65 – 340	260 – 270	26 – 27	FORE HAND	AT	
63 – 98	220 – 400	270 – 275	27 – 29	FORE HAND	#75	

PASS SEQUENCE

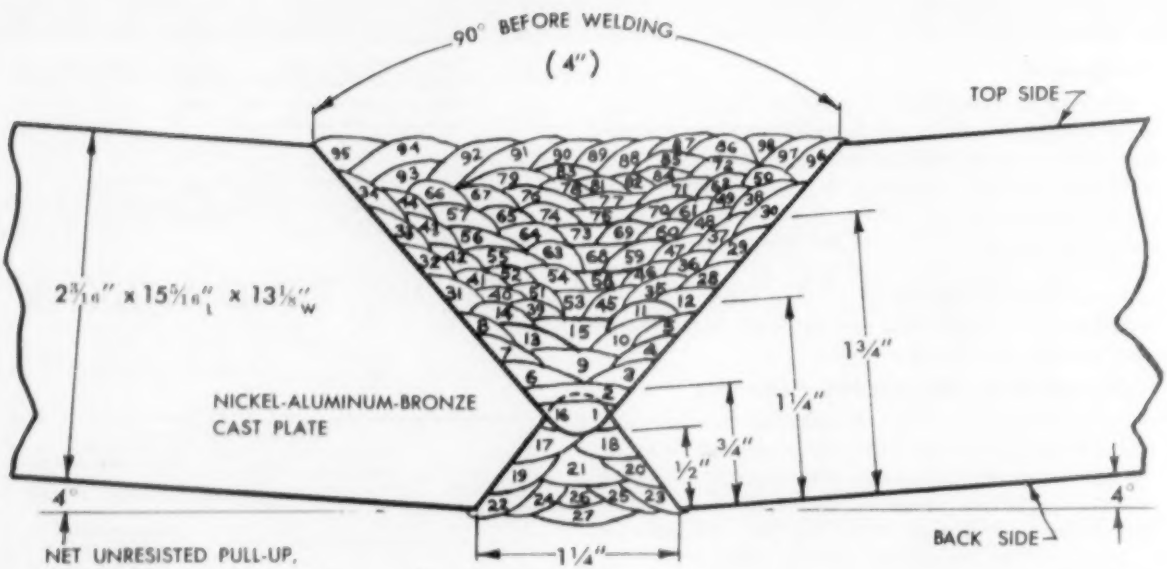

Fig. 3 Weld details: aluminum bronze filler wire; no preheat

Welding with Aluminum-Bronze Filler Wire.

It was decided to go back to a straight aluminum-bronze filler wire so the weld whose details are shown in Fig. 3 was made using a stranded 10% aluminum bronze filler wire composed of four strands twisted together to form a 5/64-in. diameter stranded wire (two strands are copper, one is aluminum and one is iron). Again, several passes were made from one side, the casting turned over, the root side chipped out and welded, then the first side was completed. There was no external preheat and the interpass temperature was that inherent in the welding process. The usability of the filler wire was excellent and no difficulties were encountered throughout the entire operation. The gas flow (argon) was 45 cu ft per hr and a total of 98 passes (all stringer beads) were deposited using 26–27 volts at 265–275 amp with a wire feed of 190–195 ipm. The approximate deposition rate was 11.7 lb per hr based on 100% arc time.

AS WELDED TEST RESULTS

STRANDED 5/64" DIAM. WIRE

TEST	YIELD ST. PSI	TENSILE ST. P.S.I.	ELONGATION	BEND ANGLE	CHARPY VEE AT 0° F
TRANSVERSE WELD TENSILE #1	—	67,350	—	—	—
TRANSVERSE WELD TENSILE #2	—	70,200	—	—	—
.505" ALL WELD TENSILE #1	43,000	84,750	21.5% IN 2"	—	—
.505" ALL WELD TENSILE #2	44,000	83,750	21.5% IN 2"	—	—
.505" ALL WELD TENSILE #3	47,500	83,000	14.5% IN 2"	—	—
.505" CAST PLATE TENSILE #1	33,500	77,750	14.5% IN 2"	—	—
.505" CAST PLATE TENSILE #2	35,750	80,250	12.0% IN 2"	—	—
TRANSVERSE WELD SIDE BEND # 1	—	—	—	37°	—
TRANSVERSE WELD SIDE BEND #2	—	—	—	48°	—
CAST PLATE SIDE BEND #1	—	—	—	46°	—
CAST PLATE SIDE BEND #2	—	—	—	41°	—
CHARPY VEE IMPACT (CASTING)	—	—	—	—	17.5 – 155 15 – 16.0 – 160
CHARPY VEE IMPACT (WELD)	—	—	—	—	25 – 26 25 – 24½ – 19

TEST SPECIMEN LOCATION IN CAST NICKEL-ALUMINUM-BRONZE PLATE

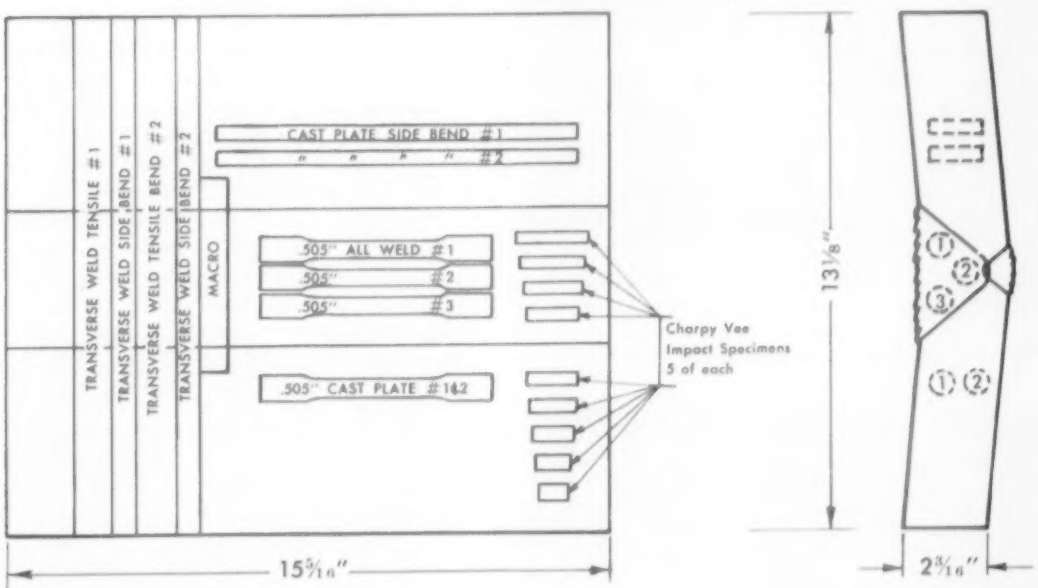

Fig. 4 Results of tests. Aluminum-bronze filler wire

Results of Tests

The test plate was sectioned as noted in Fig. 4. The types of specimens obtained were:

(*a*) Two transverse weld tensile specimens.
(*b*) Three all-weld metal 0.505 tensile specimens.
(*c*) Two transverse side bends of joint.
(*d*) Two 0.505 tensile specimens from casting.
(*e*) Five Charpy-vee impact specimens from joint.
(*f*) Five Charpy-vee impact specimens from casting.
(*g*) Two side bends from casting.
(*h*) One macrosection from joint.

As may be noted from Fig. 4, the properties of the weld are better than those of the casting. Attention is particularly invited to the results of the Charpy-vee impact tests at 0° F which indicate approximately *23.9 ft lb* for the weld deposit as compared with *16.0 ft lb* for the base casting. This low-temperature impact strength is of great importance in cold weather operations.

Table 1—Comparison of Test Results—Various Materials

Casting material	*Filler metal and process*	*YS*	*TS*	*Elongation*	*Bend, deg*	*Trans tensile*
Manganese bronze (casting)	.....	..	60,100	13.5	67	..
Manganese bronze (weld)	Manganese bronze; metal arc	..	64,500	30.0	62	55,000
Manganese bronze (casting)	.....	..	71,000	28.8	..	..
Manganese bronze (weld)	Aluminum bronze; inert-gas-shielded metal-arc	..	82,400	25.0	45	62,000
Nickel-aluminum bronze (weld)	Nickel-aluminum bronze; inert-gas-shielded metal-arc			Cracked		
Nickel-aluminum bronze (casting)	.....	34,000	79,500	13.5	44	..
Nickel-aluminum bronze (weld)	Aluminum bronze; inert-gas-shielded metal-arc	44,000	84,000	21.5	43	68,500

Table 2—Comparative Chemistry of Materials Employed

	Manganese bronze			*Nickel-aluminum bronze*		
Element	*Base metal*	*Weld, electric arc*	*Weld, inert-gas shielded metal-arc, Al-bronze filler*	*Base metal*	*Weld metal, inert-gas shielded Ni-Al bronze filler*	*Metal-arc Al-bronze filler*
Copper	57.75	63.11	88.24	81.33	80.93	89.52
Aluminum	1.00	0.69	9.80	8.43	10.49	9.12
Nickel	..	..	0.02	5.00	4.70	0.10
Iron	0.92	1.16	0.94	3.71	3.83	0.89
Zinc	39.68	32.34	0.94	0.57	..	0.11
Manganese	0.44	1.91	0.02	0.68	0.05	0.02
Tin	0.01	0.73	0.01	0.20	..	0.16

Tests of Base Casting

In connection with the results of tensile tests of base castings, attention is invited to the fact that there is always considerable discrepancy between the physical properties obtained from separately cast specimens (as required by casting specifications) and the properties of specimens taken directly from the casting itself. As proof of this, note that the values for the nickel-aluminum bronze casting used in this investigation are as follows:

Test specimen	*YP*	*TS*	*Elongation in 2 in.*
Separately cast*	44,000	91,250	19%
Taken from casting†	34,000	79,500	13½%

* This is the type specimen on which specification requirements are based.

† Average of two specimens.

Comparison of Results with Other Processes

A comparison of data obtained from the various welding processes employed on the different types of bronze castings is shown in Tables 1 and 2. Note that for manganese-bronze castings, both the metal-arc process with manganese-bronze electrodes and the inert-gas-shielded metal-arc process with aluminum-bronze filler wire have been found satisfactory for this particular alloy.

For the nickel-aluminum bronze castings, successful results have been obtained using the inert-gas-shielded metal-arc process with aluminum-bronze filler wire. To date the welds made with this process using nickel-aluminum bronze filler wire have produced only brittle, cracked deposits. It is considered that further work with a modification of this wire (reducing the aluminum to about 8½%) may produce welds of strengths higher than 90,000 psi without cracking. This work is being carried out. Until successful results are obtained with the modified nickel-aluminum bronze wire it is considered that satisfactory repairs can be accomplished in nickel-aluminum bronze propellers by use of inert-gas-shielded metal-arc process with stranded aluminum-bronze filler wire.

Conclusions

Using the aluminum-bronze filler wire with the inert-gas-shielded metal-arc process for welding nickel-aluminum bronze propellers has the following advantages:

(*a*) This procedure is applicable in various positions of welding. Metal-arc welding with covered electrodes is limited to flat position only.

(*b*) Little or no preheat is required to make satisfactory welds. This is always a decided advantage in any welding operation. Manual metal-arc welding with aluminum-bronze electrodes requires preheat as high as 800° F.

(*c*) The deposited weld metal is a fairly good color match for the casting.

(*d*) This procedure without changes in equipment or filler wire is also satisfactory for making weld repairs to manganese-bronze castings. Hence, a universal welding procedure is applicable to both types of bronze propellers.

ALL-WELDED ALUMINUM LIFT INSTALLED ON ESSEX CARRIER "BON HOMME RICHARD"

Inert-gas-shielded metal-arc welding process used to fabricate lightweight elevator for the "Bonnie Dick"

BY G. HUGHES AND C. B. ROBINSON

One of the most recent developments in the current U. S. Naval ship construction and modernization program, now in high gear, is the all-welded aluminum deck-edge elevator, believed to be one of the largest aluminum fabrications to date using a gas-shielded metal-arc welding process.

Replacing old style, all-steel elevators weighing approximately 45,000 lb, the new aluminum lifts, assembled from a variety of shapes totaling only 26,000 lb, have adequate strength despite their lightness for carrying the most modern jet planes from hangar decks to topside flight areas.

Four of the aluminum lifts have been fabricated at the San Francisco Naval Shipyard for installation on the Essex-class aircraft carriers U.S.S. *Bon Homme Richard* (see Fig. 1), U.S.S. *Wasp* and U.S.S. *Boxer*. Two are combination aluminum construction with wood platforms and two are all-aluminum jobs.

G. Hughes is a Senior Welding Engineer of the San Francisco Naval Shipyard, Hunters Point, Calif.; **C. B. Robinson** is Process Supervisor, Air Reduction Pacific Co., San Francisco, Calif.

Fig. 1 U.S.S. *Bon Homme Richard* (Courtesy of the Oakland Tribune)

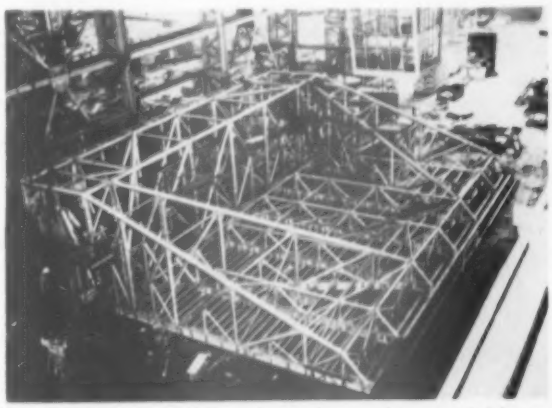

Fig. 2 Nearly 13 tons of aluminum tubing and I-beam framework were erected and welded in an inverted position to form the underpinning of a new lightweight airplane elevator designed and constructed at the San Francisco Naval Shipyard for installation on the U.S.S. *Bon Homme Richard*

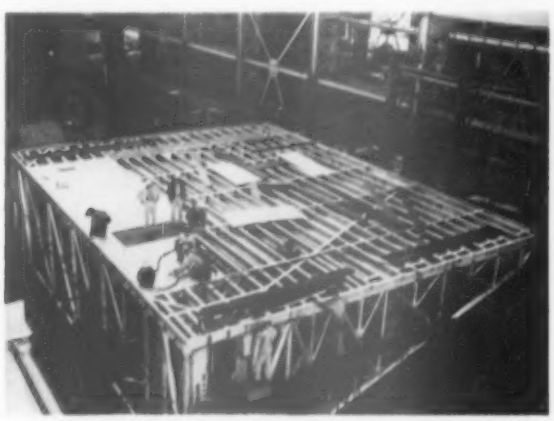

Fig. 3 Shipfitters and welders place aluminum sheet decking on framework of I-beams supported by tubular underpinning as the huge all-aluminum elevator assembled by inert-gas metal-arc welding nears completion for use on the modernized aircraft carrier U.S.S. *Bon Homme Richard*

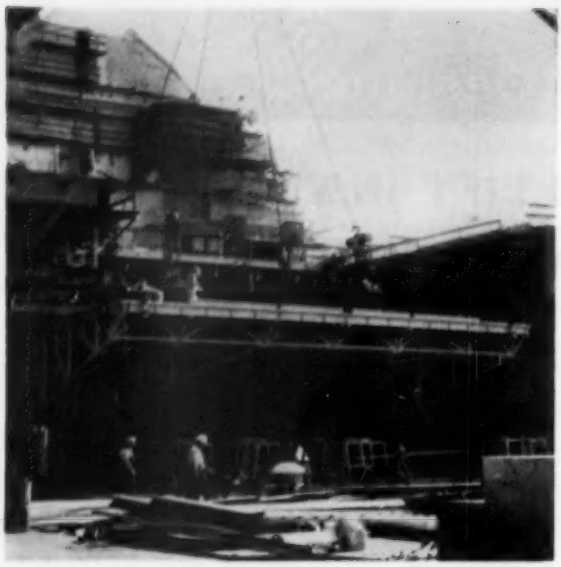

Fig. 4 Nesting into the slot prepared for it at the edge of the U.S.S. *Bon Homme Richard* flight deck is one of two huge all-welded aluminum elevators which will carry Navy jet planes between hangar deck and flight deck areas of the Essex-class carrier

The all-aluminum lift with which the "Bonnie Dick" has been equipped was designed and completely fabricated at the Frisco shipyard. Stress members of the lift are composed of aluminum tubing up to 5 in. in diameter welded to gusset plates and supporting a platform of $^1/_2$-in. thick aluminum plate reinforced and supported by a grid pattern of aluminum I-beams.

The elevator's load-bearing truss-type supporting structure was welded in an inverted position in the shipfitting and welding shop (see Fig. 2). Since the weldments were too large to position readily, all such connections were welded with gas-shielded metal-arc welding guns in the vertical, horizontal and overhead positions. One-sixteenth inch aluminum welding wire and helium shielding gas were employed.

Decking was welded with automatic inert-gas-shielded metal-arc welding after the structure had been righted and braced in its normal operating position (see Figs. 3 and 4).

Welding of the *Bon Homme Richard* lift required 451 man-days to deposit a total of 1180 lb of welding wire. Twenty-five days were required to check welds with X-ray inspection, and all welds met standards for such fabrication.

VALVE PLUGS RECLAIMED BY METALLIZING

The reclamation department at the Standard Oil Company of California plant in La Habra handles all of the repair work for their operation in South California. There are hundreds of installations, including the huge refinery at El Segundo near Los Angeles. The repair of valves, of which there are literally thousands in the area, comprises the greater part of the reclamation work. Metallizing proved a "natural" for solving some of Standard's problems.

During a careful and concise study of the process that took over a year, numerous valves were metallized, then placed in the field and refineries for testing, and closely watched. It was found that metallizing came through with flying colors. One of the valves they put out for test was in operation for more than a year. Those that were returned showed conclusively that this method was far superior to their old system and would mean the savings of thousands of dollars every year.

The reclamation department handles up to 5000 valves yearly. Most of them require reconditioning. During pumping operations they handle water, sand and oil. In the refineries they must control gasoline, oil, grease and other chemicals. The net result of all these factors is a very rough combination of abrasion and corrosion. Hard stainless steel has given the plugs a much greater life than before. It resists the corrosive action of the chemicals and is much tougher in contact with the mud and sand pumped up during the drilling.

At this same plant, a 10-in. plug is metal sprayed in 2 hr. It would take a welder two days to do the same job. Also, with metallizing very little excess metal is needed for finishing. Of course, this appreciably reduces grinding time.

Fig. 1 Reclaiming of worn valve plug by metallizing

Based on a story by Metallizing Engineering Co., Inc., Westbury, N. Y.

CONCRETE MIXERS ARE WELDED FOR EFFICIENCY

One of the most critical components of $5^1/_2$- and $6^1/_2$-cu yd truck concrete mixers (see Fig. 1) is the steel tire on which the drum rotates. Mounted at the rear of the mixer unit, the tire has to withstand shifting weights of up to 40,000 lb without cracking loose from the drum shell, losing concentricity or developing flat spots.

During day-in and day-out trouble-free operations under rugged service conditions, the steel tire performs three vital functions on the mixer:

1. Supports and stabilizes the drum itself.
2. Transmits the drum load to the supporting rollers.
3. Provides the support for one end of the drum.

Based on a story by Standard Steel Works Division, Baldwin-Lima-Hamilton Corp., Burnham, Pa.

Fig. 1 Concrete truck mixer. The mixer drum rotates on a forged $51^1/_2$-in. steel tire

Fig. 2 Forged steel tire is shown here being welded to a cone section of a $6^1/_2$-cu yd truck mixer drum. The mixer drum will rotate on the steel tire when the truck mixer unit is in operation

Tires for mixers made by the Blaw-Knox Co., Pittsburgh, are forged under closely controlled conditions at the Standard Steel Works Division of Baldwin-Lima-Hamilton Corp., Burnham, Pa. Weighing over 200 lb, the high-carbon steel rings are $51^1/_2$ in. in diameter and 3 in. wide and $1^1/_2$ in. thick. They are hot roll forged to impart extra-tough physical properties and then rough machined.

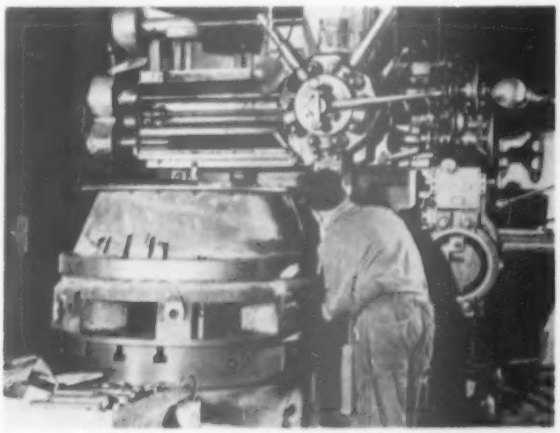

Fig. 3 Forged, high-carbon steel tire welded to a section of the truck mixer drum machined on a 5-ft boring mill. The tire is $51^1/_2$ in. in diameter and weighs over 200 lb

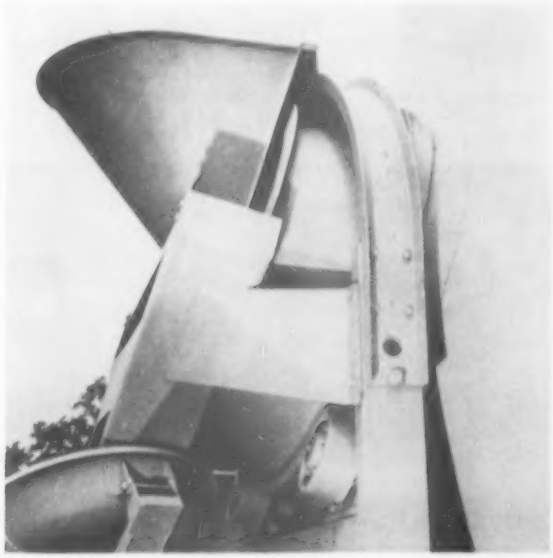

Fig. 4 Rear end of the $6^1/_2$-cu yd capacity truck mixer, showing how the drum rotates on the steel tire, supported by two heat treated rollers

At Blaw-Knox tires are assembled to the mixer drums in a special welding fixture (see Fig. 2). First the tire is slipped over the cone of the drum and tack welded into position. Then it is finish welded by hand, using a low-hydrogen electrode.

The roller track is finish-machined on a 5-ft boring mill (see Fig. 3).

The drum itself is high-strength, low-alloy steel, abrasion resistant to withstand the punishment meted out by sand and gravel and water churning inside.

The rollers on which the tire and drum rotate are made of SAE 1045 steel, machined and flame hardened (see Fig. 4).

GAS-SHIELDED METAL-ARC SPOT WELDING SAVES $1400

The Howard S. Wright Co., Seattle, Wash., recently effected a $1400 savings by using gas-shielded metal-arc spot welding to fabricate a 14-gage steel covering to protect the concrete block walls of a U. S. Post Office building there (see Figs. 1–3). This new application of gas-shielded metal-arc spot welding proved faster and more economical than both riveting and welding methods formerly used. Using gas-shielded metal-arc spot welding, it was not necessary to drill any holes in the steel. Average production time was only 8 sec per joint, including positioning, holding and welding.

The 14-gage steel plates are spot welded to 16-gage steel tabs set in the masonry walls. Tabs are spaced 20 in. apart horizontally, and 16 in. apart vertically.

As stated above, the steel sheets were clamped in place before welding. The plate fitter marked the location of each wall tab in chalk on the outside of every plate. A welding operator then made all welds with a portable gas-shielded metal-arc spot-welding machine. Each weld has a tensile strength equal to a $^1/_4$-in. steel rivet. The final result is a neat job with little or no grinding necessary.

Based on a story by the Linde Air Products Co., New York, N. Y.

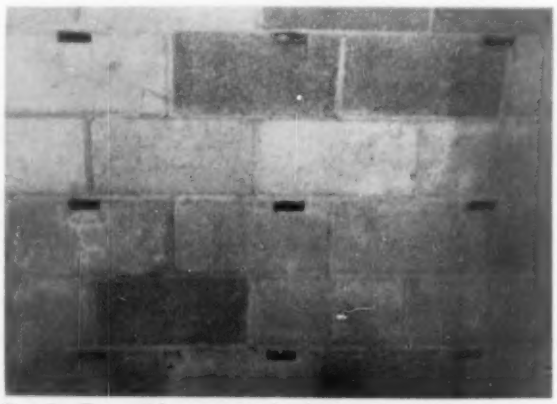

Fig. 2 These 16-gage steel tabs are set in the masonry wall. Later 14-gage steel plate is gas-shielded metal-arc spot welded to them. No hole drilling is necessary

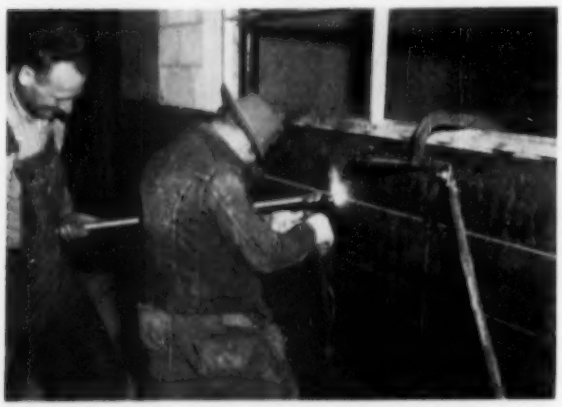

Fig. 1 Fabricating a protective steel covering for concrete walls has been proved fast, easy and economical with gas-shielded metal-arc spot welding

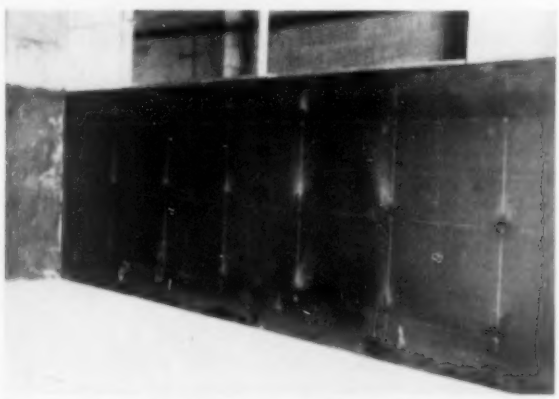

Fig. 3 Finished job. This particular wall protector was gas-shielded metal-arc spot welded at a savings of $1400 over previously used methods

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Society News

Outstanding Success Marks 1956 AWS National Fall Meeting

Cleveland Section plays host to more than 1150 members and guests

The 1956 AWS National Fall Meeting held at the Hotel Cleveland in Cleveland, Ohio, during the week of October 8, will long be remembered as one of the interesting and smoothest-run conventions sponsored to date by the American Welding Society. The unusually well-balanced program provided a diversified technical fare, together with what proved to be just the right number of business conferences and social events.

Opening-Session Events

The week's activities got underway in a most auspicious manner on Monday morning, October 8th, when President John J. Chyle presented a fine welcoming address at the official opening session. His complete text is given later in this report.

Sharing the spotlight with Mr. Chyle were the recipients of the honor awards and the Adams Lecturer.

Welding Leaders Are Honored

Leaders in the welding field were honored at the opening session for their outstanding achievements and accomplishments.

Clarence E. Jackson, research metallurgist, Metals Research Laboratories of Linde Air Products Co., was awarded the Samuel Wylie Miller Memorial Medal for outstanding research in the field of welding metallurgy.

H. C. Ludwig, research engineer, Westinghouse Research Laboratory, was awarded The James F. Lincoln Medal. Mr. Ludwig received this annual award for the article judged to be the most original contribution to the advancement and use of welding published in The Welding Journal. The winning article, "Nitrogen Effects in Argon-Arc Welding Atmosphere," was published in the September 1955 issue.

As usual, first thing Monday morning, the Registration area was a center of busy activity; everyone getting prepared for busy days to come

At the Monday Opening Session, President John J. Chyle, following his Welcoming Address, presided at the Awards Session. Clarence E. Jackson was the honored recipient of the 1955 Miller Memorial Gold Medal and Certificate, both presented by President Chyle

H. C. Ludwig was chosen by the Awards Committee as the awardee of the envied Lincoln Gold Medal (1956) and Certificate, as here presented by President Chyle

The A. F. Davis Undergraduate Awards went to Lee E. Allgood and George L. Neal. Mr. Allgood is receiving both his award and that for his University's publication in which his winning paper appeared

George E. Linnert, head of welding research, Armco Research Laboratories, presented the Adams Honor Lecture. The award, established in honor of the founder of AWS, is made annually to a scientist or engineer for outstanding work in the field of welding. Mr. Linnert's paper was entitled "The Welding of Precipitation-Hardening Stainless Steels."

Student Articles Win Welding Awards

Two engineering students were awarded cash prizes for their outstanding welding articles that appeared in undergraduate student publications. These awards, sponsored by A. F. Davis, vice-president and secretary of the Lincoln Electric Co., were also presented at the opening session.

First prize of $200 was awarded to Lee E. Allgood of the University of Michigan for his paper entitled, "Welding for Modern Processing." The *Michigan Technic* magazine was also awarded $200 for publishing the article.

Second prize of $150 went to George L. Neal, University of Denver, for his paper on "Economical Hard Facing with Cast-Iron Electrodes." The *Denver Engineer*, where the article appeared, was also awarded $150.

Win Membership Drives

The winners of the 1955–56 Henry Neitzel Membership Awards were announced formally at the opening session by Lew Gilbert, Chairman of the National Membership Committee.

The top prize for the greatest net numerical gain, as well as for the greatest percentage gain, went to the Los Angeles Section. They showed a net increase of 244 members—or a 54.6% gain.

The Chicago Section was second in the net numerical gain category with 68 new members, and the St. Louis Section was third with 39 new members.

In the net percentage category, the Peoria Section was second with a 34.6% increase, and the St. Louis Section was third with a 32.8% gain.

Los Angeles AWS Section crashed through this year by winning both numerical and percentage national membership awards. Charlie Smith, Chairman of the Los Angeles Section, has his hands "full" with the awards just presented by President Chyle and Lew Gilbert, 1955–56 Chairman of the National Membership Committee

Technical Papers Sessions

Many new welding developments for industry were revealed at this, the last of the National Fall Meetings to run concurrently with the ASM Metals Show. More than 1150 welding men attended the meeting to hear over 60 papers on advances in welding, brazing, cutting, metallizing and shop management. Among the papers delivered during the five-day meeting, a good number were devoted to the welding of titanium, aluminum, molybdenum, stainless steels and zirconium. Others discussed the welding of building structures, aircraft, piping, tubing and pressure vessels. (A complete listing of all papers is given in the September issue of THE WELDING JOURNAL, pp. 926 to 937).

The formal technical papers sessions were supplemented by an excellent educational lecture series on "Resistance Welding—Theory and Use."

Several Business Meetings Held

A number of important business meetings and related events took place during the week.

On Tuesday morning, October 9th, there were meetings of the 1957 Exposition Committee, National Membership Committee and Welding Handbook Committee. Officers of District No. 7 met for luncheon on the same day, while the Organization Structure Committee met in the afternoon.

The Publicity Committee held a meeting on Wednesday morning, October 10th. The National Nominating

Committee and the Section Advisory Committee met in the afternoon of the same day.

The Welding Research Council University Dinner and University Conference took place on Wednesday night.

A Board of Directors' meeting was held on Thursday morning, October 11th, with a Sustaining Members' and Board of Directors' Luncheon being held at noon of the same day.

Social Events

Several social events enlivened the serious business proceedings of the 1956 Fall Meeting. Two of them were of general interest. The President's Reception on Monday evening was extremely well attended, with the members and their ladies in a gay and festive mood.

The Annual Dinner, sponsored by the Cleveland Section, took place on Wednesday evening. A crowd of almost 300 enjoyed not only the excellent food, but the fine professional entertainment and the dancing period that followed.

Other Special Events

Other events of special interest included a plant tour of the Euclid Division of General Motors Corp. on Wednesday morning, and a tour of the Chevrolet Plant on Thursday morning. Many members took advantage of both trips.

The Ladies' Program of Activities included, among other things, fashion shows and sightseeing tours through interesting and cultural centers of Cleveland.

On Monday evening, the popular President's Reception got under way. About four hundred members and guests passed along the Receiving Line which was headed by President Chyle, with introductions being made by Ed Dato, Chairman of the National Convention Committee

Excellent Job by Cleveland Section

Infinite credit must be given to the members of the Cleveland Arrangements Committee for the extremely fine job done in the arrangement and fulfillment of the various details. The group included T. L. Dempsey, Chairman; C. T. Elder, Secretary; W. P. Mayor, Dinner; O. J. Bornemann, Hospitality and Signs; R. J. Kriz, Housing; A. P. Stern, Ladies' Entertainment; J. C. Wyss and J. E. Mallett, Meeting Sessions; W. E. Mumford, Plant Tours; H. G. Hinkel, President's Reception; C. P. Berka, Jr., Publicity; R. Pagenkopf, Technical; R. W. Metzger, Jr., Ticket Sales; and F. G. Flocke, Member-at-Large.

In all, it was a very gratifying and very profitable experience. Our thanks to those who made it possible.

Welcoming Address

By J. J. CHYLE

President, American Welding Society

It is a great pleasure to welcome old friends and acquaintances to the 37th National Fall Meeting of the AWS. It is particularly gratifying to see many new faces and we all feel that the benefits received by attending the technical sessions and the social contacts we make at these meetings more than justify the expense and the efforts of attending.

First of all, I would like to tell you of some of our headquarters activities that will be of interest to you.

On June 18th of this year Joe Magrath, our National Secretary, suffered a severe heart attack. He was hospitalized for many weeks and gradually has recovered to a point where I am very happy to tell you that he again is back on a part-time basis in the activities of our Society. In fact, Joe is here at our meetings, but will of necessity share the brunt of the work with his assistant, Frank Mooney.

I also want to tell you that, in Joe's absence at our office headquarters, our Assistant Secretary and Treasurer, Frank Mooney, took over his work and I have personally visited our New York office on several occasions and have found that the affairs of our Society were being very efficiently carried out.

I am sorry to inform you about the death of Harry C. Boardman, who died on August 6th in Chicago. As you know, Mr. Boardman was Past-President of the AWS in 1929. He was also Chairman of the Welding Research Council for many years and had been Chairman of the Boiler and Pressure Vessel Code Committee of the American Society of Mechanical Engineers. He had been a member of numerous important AWS committees and his loss will be keenly felt by all of us.

In addition to being so active in the AWS, he had an enviable reputation as an outstanding engineer and contributed some pioneering developments in the field of design of storage tanks and pressure vessels.

You may also be interested to know that our current membership, as of Sept. 1, 1956, totals 11,731. This is a very substantial increase in membership and is due to the efforts of you and, in particular, Lew Gilbert, past-chair-

People at the Reception soon got together in groups; some talking about this and that as must be C. B. Voldrich, E. M. MacCutcheon, Doug Hopper and Past-President Fred Plummer

Everyone of these "celebrants" has a great deal of interest in shipbuilding. But it is hard to believe that the tale being told by Jack Cahill to Captain R. D. Schmidtman, La Motte Grover, George Place and Dave Brown has anything to do with ships. What do you think?

man of our Membership Committee and our present new chairman, Al Pearson. I hope that in the coming year we can continue with an increase in membership and that by the end of our fiscal year we will be well over 12,000. We need this growth to be healthy and to expand, in order that we can increase our services to you.

We must never lose sight of the fact that our SOCIETY is primarily a service organization. Our services go to groups whose interests are sometimes widely divergent. We must be of ever expanding service to the welder in the shop, to the aspiring student, to the welding engineer, to the design engineer and to industrial management. Yes—the AWS is truly a service organization.

It also provides a direct and ever existing line for communication, contact and interchange of ideas between the SOCIETY members and its Section Officers; also, its District Directors and its Board of Directors. This path is straight and short in either direction. We hope that you will feel free to contact your Section officers, your District Directors, Board of Directors or any other officer of our SOCIETY with regards to improvements in any manner possible to further our service to you and to the industry.

You may also be interested to know that with the additional activities at our National Headquarters it was necessary to increase our working space. We have a Headquarters Housing Committee appointed that is going to give consideration to this problem. This Committee is under the Chairmanship of Joe Humberstone.

At the present time we are going to expand our facilities by acquiring additional space on the 7th floor of the Engineering Societies building. It may be advisable in the future for us to seek a new home for our National Headquarters and I am sure that the Headquarters Housing Committee will find a suitable solution to this problem.

We now have a new special committee on Reorganization Structure. Our present structure regarding the management of our SOCIETY was organized in 1919 and is not adequate for our present needs. This Committee has considered this condition and is studying a new structure to take care of our present needs and to provide for future needs. The recommendations of this Committee will be presented before the whole membership for approval by letter ballot. This Committee, with Fred Plummer as Chairman, will consider the basic structure change with regards to officers and directors, in order to pinpoint responsibilities and allocate the tasks in running this organization more equally.

We have also given some thought to the knotty problem of Welders Certification. This is a difficult matter to solve, but our Committee, with Mr. Stetina as Chairman, is active and we hope that in the future they also will be able to solve this problem.

During the past year we have given a great deal of time and consideration to the organization of an Educational Committee. Your Board of Directors, at the last meeting in Buffalo, approved the organization of this Committee and the scope of its action. The Chairman of this very important Committee is Clarence E. Jackson. I shall mention only briefly that we consider this as being one of our most important activities and that it will be organized in many areas. It will include educational courses at the section and national levels. It also will include in-plant training, extension training, college training, trade school training and visual aids.

The effects of this educational activity, I am sure, will be felt by all members of our Society and it is our belief that it will further the objectives of our SOCIETY as stated in the constitution of our SOCIETY.

We have a new active committee called the Members Classes Committee, with Mr. Sander as Chairman, which is considering membership classification. We have the thinking of three groups

on this, which is as follows:

1. Our AWS is a professional society and the programs are planned for professional and technical members.

2. This group believes that we should have welding operators included in our membership; there being about 300,000 welders and operators in the United States. Programs should be planned to include these people at the convention and section levels.

3. This group believes that our membership classes should be left as is.

You will at a later time read and hear more about the recommendations of this special Committee.

I would at this time like to briefly comment on the meeting of the International Institute of Welding which was held in Madrid, Spain, this last July 1st to 8th. We had a very good attendance at this very pleasant meeting, which included about 24 American representatives—some of them being accompanied by their wives. The American representatives on the IIW is through the American Council of the IIW and is composed of three organizations: (1) Welding Research Council, (2) Ship Structures Committee and (3) American Welding Society.

William Spraragen heads the American Council. These 24 American members represented the three groups which I mentioned and I am sure that it was the consensus of opinion that the meeting was extremely worth while.

At the present time the IIW has members in 25 foreign countries. Some of the keenest minds in the field of welding are represented in this organization. The official languages which are spoken and in which the various papers are delivered are English and French.

The total attendance of the various delegates to this organization meeting in Madrid was approximately 1000. I attended these meetings and also spent about five weeks in Europe visiting a number of electrode plants and steel fabricating companies in Italy, Germany, Holland, England and Scotland.

The one thought which I would like to leave with you with regards to the activities of our friends in Europe is that they are NOT behind us in the field of welding. They are up with us and follow American practices and technical information very closely. In fact, they read all of our technical magazines and are thoroughly familiar with the activities of the AWS and make good use of the information and technical data which we present at meetings such as this one.

My observation has been that in Europe a great deal of attention is focused on the conservation of material and a greater effort is being expended to welding design. The business activities in the heavy industry field where welding is used is at a very high peak. Reconstruction is going on all over Europe. I am sure that they are going to give us keen competition in world markets

It is with some regret that this joint annual meeting with the American Society for Metals is going to be our last. For the best interests of our Society, however, your officers and directors feel that the problems associated with the ever increasing attendance, together with the difficulties in hotel accommodations and the crowded conditions at the Metal Show, has made it necessary for us to hold our annual meetings in spring.

To date we have held four annual meetings: one in Houston, one in Buffalo, one in Kansas City and this last spring meeting again in Buffalo; our next meeting is to be held in Philadelphia.

Those of you who have attended these spring meetings have indicated that you were more than satisfied with this arrangement. This has also been borne out by the comments of the manufacturers who exhibit their products and by those attending our technical sessions.

The very necessity for separating is a great tribute to what this Society and the ASM are doing. It is a testimonial to the fact that we have been successful in the ever increasing membership of both organizations, and by the large and increasing attendance with each meeting.

And, of course, where there is a Texan—you always find more Texans. Percy Pennybacker seems to be showing Al Pollard, Jim Henson, Jack Allen, Frank McBee and Prof. Myron Begeman, just how big this Reception would be if it were held in Texas. But Percy, what about the thing in your left hand? Could you buy it in Texas?

Folks from Maryland get together real fast when away from home. Eller Lutes seems a bit engaged with Bernice McPherson while her husband, M. E. McPherson, keeps an open eye on things

We are all aware of the fact that our industrial productivity is increasing year by year and that one of the most important factors in this increased productivity is the application of new welding processes and welding procedures. Everyone should be perfectly aware that there is more and more productivity going on in this country and we must all realize that we have not reached the top by any means. This will go on and on and the industry productivity which is ahead of us will also increase proportionately as we find or discover new welding processes and technical data that will reduce the amount of labor and the cost of welding.

This is not based on the hopeful thinking of economists, for we know that within the next few years there is going to be about 60 million additional families in this country which, of course, will require more goods in the line of automobiles, televisions, aircraft, more applications of electrical power produced by atomic energy, etc.

Industry will be faced with problems in keeping abreast with this tremendous increase and welding is going to be one of the important phases with which this can be accomplished. The future is indeed a challenging and a wonderful one for everyone involved in the field of welding.

I have had a little experience in being associated in the various phases of welded construction for application related to atomic energy for power applications. Here is a brand new field developed since the drop of the atomic bombs at Hiroshima. In this field the highest skill obtainable, together with the most precise welding processes, have been developed in the construction of many of the elements that go into the conversion of atomic energy to electrical power.

I know of no other industry where such high quality is of the utmost importance and it is a tribute to many of our associates who are applying welding at the various atomic energy processing plants, that they have developed many new methods and procedures for the extremely high requirements and the critical operations that they are engaged in.

The future is an immense one and the future of the AWS is immense too.

We are glad that there are new and younger members at meetings of this kind, who are coming up and will take over some of these very important developments for us in the future.

Naturally, there was music—from the accordian, that is! It was quite difficult to understand what it was that Roy Clark and his pals were contributing! Anyway, it was a grand meeting. Thanks, to all who made it possible

90,600?

Yes . . . in a 12-month period from July 1955 to June 1956, 90,600 reprints of vital articles in The Welding Journal were requested . . . proof of the authoritative editorial calibre of The Welding Journal. Proof, too, of the acceptance by the welding and allied industries of The Welding Journal's high standard of reporting.

Program for American Welding Society 1957 National Spring Meeting Announced

Three Sessions to Be Sponsored by AIEE Committee on Electric Welding

Where and how welding is being used in the fabrication of nuclear power plants will be the subject of two technical sessions at the forthcoming National Spring Meeting of the AMERICAN WELDING SOCIETY. The meeting will be held in conjunction with the Fifth Welding and Allied Industry Exposition in Philadelphia, April 8–12, 1957.

Several papers will discuss welding problems involved in designing and fabricating nuclear reactors. Recently developed procedures and techniques for welding reactor components will also be described. Other papers will cover the effect of neutron radiation on weldability and mechanical properties of structural metals.

A special feature of this meeting will be the sponsoring of three sessions by the Committee on Electric Welding of the American Institute of Electrical Engineers. Paralleling the arrangements made with the ASME for the 1956 Spring Meeting, the AIEE will meet with AWS in Philadelphia and sponsor papers that are of similar technical interest to both groups. Two of the sessions will deal with resistance welding, the third will cover arc welding.

A total of 18 sessions are planned for the five-day meeting. In addition to the above-mentioned papers, latest developments in other fields of welding activity will be reported. These include welding of titanium and zirconium, brazing stainless steels and high-temperature alloys, new techniques in precision welding control, filler metals for welding high-strength steels, zinc soldering of aluminum, welding of missile airframes and the use of welding in foundries.

Two of the sessions will be devoted to the latest advances in welding research. Subjects to be covered include factors affecting weld toughness and the influence of design on brittle fractures.

All technical sessions will be held at the Hotel Sheraton, AWS Headquarters for this meeting. The Welding Show, featuring exhibits and demonstrations of the latest equipment, filler metals and supplies used in the welding industry, will be located at Convention Hall.

AWS DIRECTORS-AT-LARGE

Term Expires	1957	1958	1959
	R. W. Clark	F. H. Dill	J. H. Blankenbuehler
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	Hal Savage	J. L. Wilson	Gordon Parks
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JOIN AWS!

Through membership in AWS you keep abreast of the latest developments in welding, welding engineering, welding metallurgy and procedures, by the contacts you make and through its local national meetings and publications. Investment in AWS membership cost less than your daily newspaper, but brings you tremendous and perpetual dividends, and information on how to produce improved products, increase productivity, and lower production costs through modern welding procedures. Send for descriptive brochure to AMERICAL WELDING SOCIETY, 33 W. 39th St., New York 18, N. Y.

More Companies Enroll As Supporting Members

Four more organizations have enrolled recently as Supporting Company Members. They are as follows:

ACF Industries, Inc., Berwick Plant, Berwick, Pa.

Allied Welder Corp., 8700 Dearborn St., Dearborn, Mich.

International Nickel Co., 1321 Edgar St., Evansville 7, Ind.

Huber-Warco Co. 202 N. Greenwood St., Marion, Ohio.

All four enrollments became effective as of November 1.

First Meeting Held by Cal Poly Student Chapter

On the evening of October 10th, the student chapter of the AMERICAN WELDING SOCIETY at the California State Polytechnic College held the first meeting of the school year. The program featured two speakers from the Westinghouse Electric Corp.

Wallace J. Erichsen, manager, Materials Test Laboratory, discussed "Basic Welding Metallurgy." Lambert A. Mayr, welding engineer and Cal Poly graduate of 1955, spoke on "The Engineer from College to Industry—A Transition."

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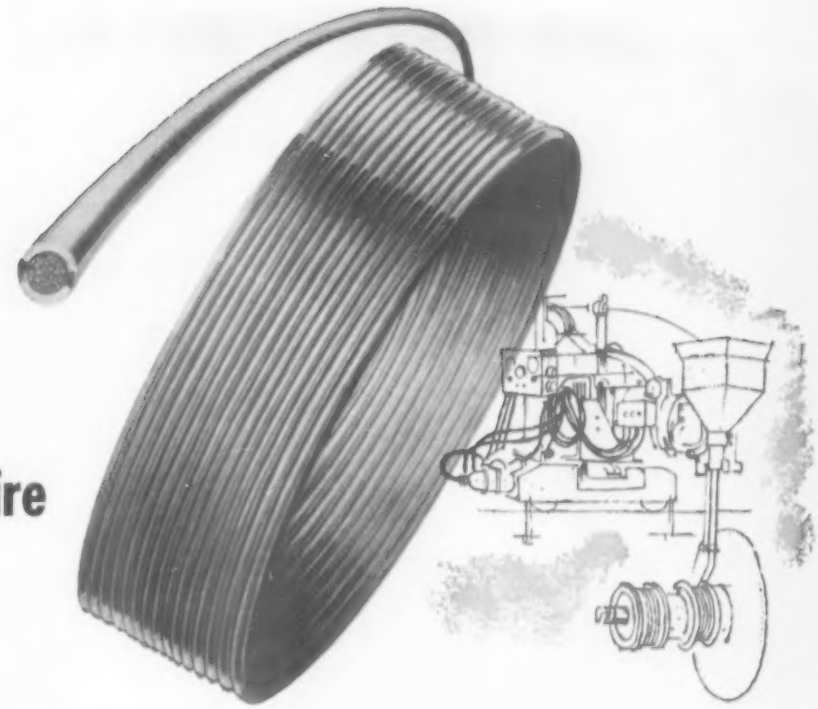

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HAYNES drawn tube wire is an important innovation in the hard-facing field and is designed to make automatic and semi-automatic deposition even more practical. It successfully combines the uniformity of composition and the economy offered by tube rod, with the ease of application of solid welding wire. In addition, standard wire tolerances for roundness and concentricity are strictly adhered to in order to insure trouble-free application. HAYNES drawn tube wire feeds smoothly and uniformly in any standard welding machine without the aid of special adaptors. Kinks and twists which sometimes hamper tube rod deposition are minimized. Deposits of this newly developed product are dense and sound.

Coils of drawn tube wire are now available in the following alloys: HAYNES 90, HAYNES 93, HAYNES 4560, HAYNES 5260, HASCROME, and HAYNES Nickel-Manganese. The variety of properties offered by these iron-base alloys insures a solution to a great many wear problems encountered in practically every industry and especially in the mining and construction fields. Drawn tube wire comes in 3/16 inch diameters only.

For more information on the complete line of HAYNES tube rods in coils or on any of the 19 HAYNES hard-facing alloys, write to any of the district offices listed below.

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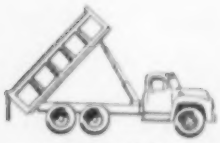

For some time, dump truck operators have cast longing eyes at the light weight and high payloads that aluminum dump bodies would make possible. But nobody knew how to weld aluminum bodies strong enough or fast enough.

But recently two important things happened: the shielded arc, inert gas, consumable-electrode method was developed and improvements were made in Alcoa Alloy 5154. Used with the new welding techniques, alloy 5154 now provides a 25% increase in strength across welds and a 150% increase in ductility.

Speed is way up, too. Penn Body Division of Hockensmith Corporation, a leading dump body builder, butt welds $\frac{3}{16}$ inch sheet at speeds up to 30 inches per minute, compared with 16 inches per minute for the tungsten arc process. Depending on conditions and equipment, speeds as high as 60 to 80 inches per minute are now possible.

Now, companies like Penn Body offer a complete line of dump bodies that weigh only half as much as steel but with equivalent, or better, stiffness and impact resistance.

To make the bodies, Penn Body first butt-welds the floor from two sheets of 5154 alloy. Cross bracing is then added by skip-welding extruded beams of 6061-T6 alloy. Longitudinal members are welded in position and the sides and front, press braked from 5154 sheets, are welded in place.

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Pacific Metal Co.
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Metal Goods Corp.
MARYLAND
Baltimore
Southern Oxygen Co.
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MASSACHUSETTS
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MISSOURI
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St. Louis
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NEW JERSEY
Camden
Southern Oxygen Co.
Harrison
Whitehead Metal Products Co., Inc.
NEW YORK
Albany
Eastern Metals Warehouse, Inc.
Buffalo
Whitehead Metal Products Co., Inc.
New York
Whitehead Metal Products Co., Inc.
Syracuse
Brace-Mueller-Huntley, Inc.
Whitehead Metal Products Co., Inc.
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Charlotte
Southern Oxygen Co.
Greensboro
Southern Oxygen Co.
OHIO
Cincinnati
Williams & Co., Inc.
Cleveland
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Columbus
Williams & Co., Inc.
Toledo
Williams & Co., Inc.
OKLAHOMA
Tulsa
Metal Goods Corp.
OREGON
Portland
Pacific Metal Co.
PENNSYLVANIA
Philadelphia
Southern Oxygen Co.
Whitehead Metal Products Co., Inc.
Pittsburgh
Williams & Co., Inc.
York
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Salt Lake City
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WASHINGTON, D. C.
Southern Oxygen Co.
WISCONSIN
Milwaukee
Machinery & Welder Corp.

THIRD ANNUAL MIDWEST WELDING CONFERENCE—JAN. 30–31, 1957

Sponsored by Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

WEDNESDAY, JANUARY 30th

MORNING SESSION. *Chairman:* Glen O. Fruit, Chairman, Iowa-Illinois Section, AWS

8:45 Welcome.

9:00 "Research and Applications of Stud Welding," R. C. Singleton, Vice-President—Engineering, Nelson Stud Welding, Lorain, Ohio.

10:00 "Trouble-Free Service from Stainless Steel Weldments," George Linnert, Research Welding Metallurgist, Armco Steel Corp., Baltimore, Md.

11:00 "Role of Inert-Gas Welding in Industry," J. E. Dato, Assistant Manager, Welding, Linde Air Products Co., New York, N. Y.

AFTERNOON SESSION. *Chairman:* Francis J. Harencki, Chairman, Milwaukee Section, AWS

2:00 "High Temperature Brazing," P. Patriarca, Metallurgist, Oak Ridge National Laboratory, Oak Ridge, Tenn.

3:00 "Welded Fabrication of a Homogeneous Reactor Core and Pressure Vessel," F. V. Daly, Welding Supervisor, Newport News Shipbuilding and Drydock Co., Newport News, Va.

4:00 "Welding of Equipment for Nuclear Plants," Norman Block, Consulting Metallurgist, Foster Wheeler Corp., New York, N. Y.

THURSDAY, JANUARY 31st

MORNING SESSION. *Chairman:* Gustav A. Rehm, Chairman, Sangamon Valley Section, AWS

9:00 "Application of Welding for Salvage of Machine Parts," Jack D. Robinson, Assistant Factory Manager, Bendix Aviation Corp., South Bend, Ind.

10:00 "Fire Safety for Welding and Cutting Operations," E. E. Williams, Special Engineer, Factory Insurance Assn., Chicago, Ill.

11:00 "Pressure Welding," Arnold P. Lage, Supervisor, Welding Group, Menasco Manufacturing Co., Burbank, Calif.

AFTERNOON SESSION. *Chairman:* Jean J. Revelt, Chairman, Fox Valley Section, AWS

2:00 "Distortion in Welding—Causes, Prevention and Cure," J. R. Stitt, Research and Welding Engineer, R. C. Mahon Co., Detroit, Mich.

3:00 "High-Frequency Resistance Welding," Wallace C. Rudd, Vice-President, New Rochelle Tool Corp., New Rochelle, N. Y.

4:00 "Fabrication by Welding of Aluminum Structures," O. H. Kuhlke, Welding Engineer, General American Transportation Corp., Sharon, Pa.

CAL POLY STUDENT CHAPTER HOLDS FIRST MEETING

Picture taken at the October 10th meeting of the Student Chapter of AWS at California State Polytechnic College. Left to right are: James Miller, chapter vice-chairman; L. A. Mayr and W. J. Erichsen, technical speakers; Wayne Marcellin, chapter chairman, and Ralph Miller, secretary-treasurer

Clarence P. Sander

AWS NATIONAL OFFICERS NOMINATED FOR 1957–58

The nominations for national officers of the AMERICAN WELDING SOCIETY for the 1957–58 fiscal year have recently been announced by the AWS National Nominating Committee. The names of those leaders who, in the opinion of this Committee, are best qualified to guide the destinies of the SOCIETY during the next year are as follows: Clarence P. Sander, president; Gustav O. Hoglund, first vice-president; Charles I. MacGuffie, second vice-president; Harry E. Rockefeller, treasurer; James F. Deffenbaugh, Alfred E. Pearson, Clarence M. Styer and Robert M. Wilson, Jr., directors-at-large, 1957–60.

In addition, the following nominees for district directors for the 1957–59 term have been selected by the duly appointed District Nominating Committees: Harry E. Miller, District 3; Lew Gilbert, District 5; A. F. Chouinard, District 7; Percy V. Pennybacker, District 9; Charles B. Robinson, District 11.

Short biographies of each of these nominees follow.

Nominated for President

Clarence P. Sander

Clarence P. Sander is general superintendent, Vernon Plant, of Consolidated Western Steel Division of United States Steel Co. at Los Angeles, Calif.

Mr. Sander was formerly with the Pacific Car & Foundry Co., Seattle, Wash., and Portland, Ore., in the Engineering Department, and chief estimator and later assistant general manager for many years, handling labor problems and production for both plants.

He joined the Western Pipe and Steel Co. in 1934 as general superintendent of shop and field operations, Southern Division, until it became a part of the Consolidated Western Steel.

Mr. Sander is a graduate of Wilson's College, Seattle, Wash., with postgraduate work in engineering at the University of Washington and the University of Southern California.

He has been a member of AWS for 21 years, sustaining member since 1937; past-chairman of Los Angeles Section AWS; vice-president Western District AWS, 1946–47; 2nd vice-president of AMERICAN WELDING SOCIETY, 1955–56, 1st vice-president of AWS, 1956–57, member of the Welding Research Council and the American Society of Metals and API, besides various social and civic clubs.

His experience covers a broad field in welding such as railroad equipment, shipbuilding, pipe line, boilers, penstocks, pressure vessels, oil refinery installations, steel structures, tank and various other welded products.

Nominated for First Vice-President

Gustav O. Hoglund

G. O. Hoglund is head of the Welding Section of the Alcoa Process Development Laboratory. He is a native of Milwaukee, Wis. After attending that city's primary and preparatory schools, he studied aeronautical engineering at the University of Michigan, and was graduated in 1925 with a Bachelor of Science degree.

For the next two years Mr. Hoglund worked in the Bureau of Aeronautics, Navy Department, in Washington, D. C., designing airplane propellers. His next position was at the University of Minnesota where he served as assistant professor of aeronautics during the college term of 1927–28.

Mr. Hoglund first became affiliated with the Aluminum Company of America in 1928 and for the next two years was employed in the Central Metallurgical Division. In 1930 he was placed in charge of the development of welding processes for aluminum.

He is now in charge of the Welding Division in the Alcoa Process Development Laboratories. He is also chairman of Alcoa's Subcommittee on Joining and proudly wears Alcoa's twenty-five year pin.

Mr. Hoglund is the author of a number of technical articles which have appeared in THE WELDING JOURNAL, the *SAE Journal* and *Mechanical Engineering*. He has been active in the AMERICAN WELDING SOCIETY, serving as a member and chairman of many committees. His AWS activities include the following: 2nd vice-president, 1956–57; Board of Directors; Technical Council; Technical Papers Committee—Past-Chairman; Finance Committee; AWS-ASTM Committee on Filler Metal; Subcommittee III—Aluminum and Aluminum Alloy Filler Metal—Chairman; Brazing Committee; and Pittsburgh Section—Past-Chairman.

In addition, he has served on the Boiler Code Subcommittee on Welding of the American Society of Mechanical Engineers.

In 1939 Mr. Hoglund was the recipient of the Lincoln Gold Medal for a technical paper on "Spot Welding the Aluminum Alloys."

Nominated for Second Vice-President

Charles I. MacGuffie

Charles I. MacGuffie was graduated from Penn State in 1925 with a B.S. in E.E. He completed the General Electric Co. Test Course in 1925. He was welding specialist for Atlantic District of General Electric Co. from 1928 to 1939, operating out of Philadelphia. In 1939, he was transferred to Schenectady, N. Y., as assistant manager of sales, Welding Divisions, and in 1951 he was appointed manager of Marketing, Welding Department.

Mr. MacGuffie's AMERICAN WELDING SOCIETY activities include: chairman, Philadelphia Section; member-at-large, Board of Directors; chairman, Manufacturers Committee, Public Relations Committee and Exposition Committee; member, Welding Journal Committee, Reserve Funds Committee and Technical Papers Committee.

His other activities include: Past-chairman, Welding Section of National Electrical Manufacturers Assn.; member, American Institute of Electrical Engineers and American Ordnance Assn.

Nominated for Treasurer

Harry E. Rockefeller

Harry E. Rockefeller graduated from Massachusetts Institute of Technology in 1922. Upon graduation, he was employed by the Linde Air Products Co. as a service operator in the Sales Department. Mr. Rockefeller has held various positions within the company, and is now manager of Electric Welding. He was intimately associated with most of the developments of the Linde Air Products Co., including such processes as flame-deseaming, flame-gouging, plate-edge preparation and inert-gas-shielded arc welding. Mr. Rockefeller also played an important part in the development of oxyacetylene welding for pressure vessels, and the subsequent adoption of standards of design and construction for pressure vessels.

For many years, Mr. Rockefeller has been a sustaining member of the New York Section of the AMERICAN WELDING SOCIETY. He has served as a member of the Executive and Finance Committees as well as of other committees for that organization. In addition, he has been active in the International Acetylene Assn., Compressed Gas Assn. and the American Society of Mechanical Engineers. He is the author of many papers on welding and related processes.

Nominated for Director-at-Large, 1957–60

James F. Deffenbaugh

James F. Deffenbaugh is presently employed as Chief Electrical Engineer for the Federal Machine & Welder Co., Warren, Ohio. He is responsible for all electrical application and design of the company's two principal products, Federal resistance welders and Warco presses. He also directs all development and research projects, as well as the activities of the experimental laboratory.

Before joining Federal in 1944, Mr. Deffenbaugh was employed by the Ohio Public Service Co. in Sandusky and Warren in various engineering capacities in the electrical distribution and substation fields.

He is Chairman of the RWMA Technical Committee, Vice-Chairman of the AIEE Electric Welding Committee, a member of the AWS Technical Papers Committee, Sub-Committee IX and the Seam Welding Sub-Committee of the Welding Research Council, as well as holding active membership in other technical societies. He is author or co-author of numerous technical papers and has taught night school classes for Case Institute of Technology.

As Chairman of the RWMA Technical Committee, one of his duties is directing the preparation of an ICS Resistance Welding Course which will soon be available.

Mr. Deffenbaugh is a registered engineer and received his technical education from Miami University and the University of Wisconsin.

Alfred E. Pearson

Alfred E. Pearson was born in Birmingham, Ala. He graduated from Alabama Polytechnic Institute (Auburn) in 1941 with a degree in Civil Engineering. Before graduating from Auburn he worked during summer vacations as fitter and welder in the shops and shipyards of the Ingalls Iron Works Co. at Birmingham and Decatur, Ala., and after graduation he was employed as assistant to the welding engineer. After several promotions he was made Chief Welding Engineer for the Ingalls' organization in 1947 and has served in that capacity since.

Mr. Pearson has been an active member of the AWS Birmingham Section, having served two terms as Chairman and several years as a director of that section. He is a member of the Structural Steel Research Committee, the Fatigue of Welded Joints Committee and the advisory group of Open Web Expanded Beams of the Welding Research Council. He is also a member of the AWS Committee on Building Codes.

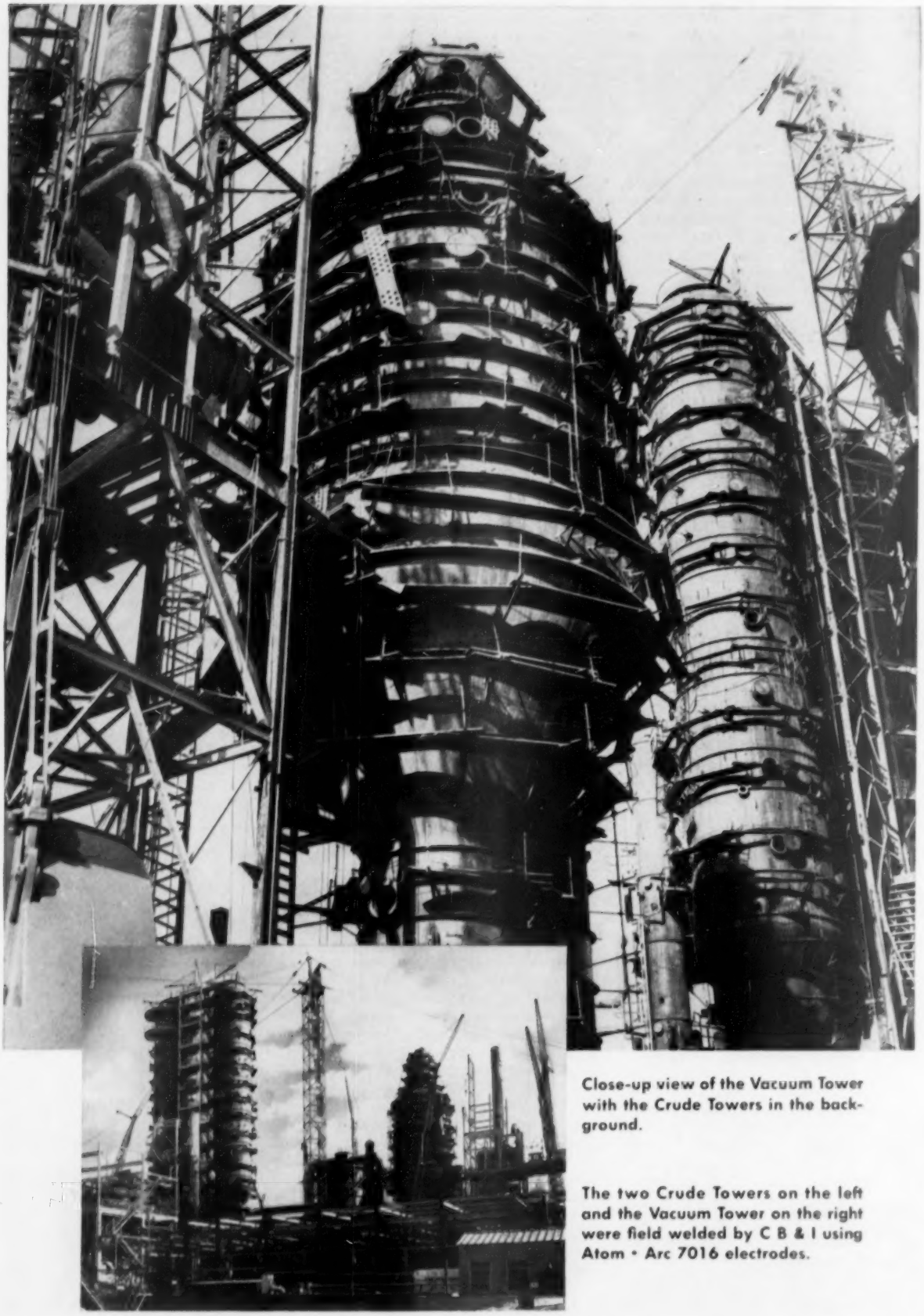
Mr. Pearson has served the SOCIETY at the National level as a past member of the National Nominating Committee and as District Director for the Southeastern District for an extended term. He is presently a member of the Public Relations Committee, a Chapter Committee on Training and Qualification of Welding Personnel for the WELDING HANDBOOK, and is Chairman of the National Membership Committee.

Clarence M. Styer

Clarence M. Styer was born and educated in Huron, S. Dak. He is a graduate of South Dakota State College with a degree in Civil Engineering. His engineering and business experience has been in railroading, shipbuilding and with steel fabricating companies in various capacities including engineer, superintendent in plant and erection and plant manager. Since 1936 he has been associated with the Pacific Car and Foundry Division in Seattle, Wash.

Mr. Styer pioneered the use of arc welding in steel fabrication as early as 1922 and has been a licensed Professional Engineer in Structural Engineering in Washington since 1936.

He has been a member of the AMERICAN WELDING SOCIETY since 1941 and has held various positions in the Puget Sound Section including that of Section Chairman. He has been a representative from District No. 7 on the National Nominating Committee and was elected District Vice-President from that dis-



Close-up view of the Vacuum Tower with the Crude Towers in the background.

The two Crude Towers on the left and the Vacuum Tower on the right were field welded by C B & I using Atom • Arc 7016 electrodes.

Welded with ATOM·ARC 7016

CB&I reports more than 1 1/4 miles of field welds with less than 1/5 of 1% of X-rayed welds chipped and re-welded!

Chicago Bridge & Iron Company, one of this country's leading builders of tanks and processing structures, used Atom • Arc 7016 electrodes on this field erection job at the Sinclair Refinery in Marcus Hook, Pennsylvania. Their report on the building of this 138-foot Vacuum Tower and the two 176-foot Crude Towers makes amazing reading. For example, on the Vacuum Tower there were 2500 feet of field welds with only 8 inches of X-rayed welds that had to be chipped out and re-welded.

A summary report shows that there were 649 X-rays made on the job. 626 were satisfactory, 23 showed defects of one kind or another but only 15 were defects in field welding. A total of 6720 feet of welds (over 1 1/4 miles) were made with Atom • Arc 7016 electrodes and only 12 feet of X-rayed welds had to be chipped out and re-welded (less than 1/5 of 1%)!

All stainless clad sections in these towers were welded with Arcaloy 309 Stainless Steel Electrodes.

Quality workmanship is the paramount consideration at Chicago Bridge & Iron. Their report on this Sinclair job is enough to indicate that they get this high quality with Atom • Arc electrodes.

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trict in 1953. When District No. 11 was formed he continued as District Director, which office he holds until May 1957. Mr. Styer also holds numerous committee memberships in AWS. He is a member of the Army's Ordnance Advisory Committee on the Welding of Armor, a member of the Seattle Engineers Club and the American Ordnance Assn. and is presently a member of that association's armor committee of the combat and tactical vehicle division.

Robert M. Wilson, Jr.

Born and educated in Montclair, N. J., Robert M. Wilson, Jr., later attended and was graduated from Cornell University in 1932 with a degree in Mechanical Engineering. From 1933 to 1945 he was employed by the General Electric Co., first in Schenectady, N. Y., then in Bloomfield, N. J., principally as welding engineer. In 1946 Mr. Wilson joined the International Nickel Co. as welding specialist of the technical service section of the Development Research Division.

Since 1955 he has followed the development in the power field while still a member of the development and research division.

Mr. Wilson is presently a member of the ASME Boiler and Pressure Vessel Code, Non-Ferrous Subcommittee, Welding Subcommittee, Unfired Pressure Vessel Subcommittee. He is also a member of the AMERICAN WELDING SOCIETY Technical Activities Committee, Past Chairman AWS New Jersey Section, past member AWS Resistance Welding Committee, past-chairman of the Pressure and Soldering Committee AWS.

Nominated for District Director, 1957–59

Harry E. Miller
District 3, North Central

Harry E. Miller is chief manufacturing engineer in the Coil Division of the Carrier Corp., Syracuse, N. Y. He has completed 31 years of successful welding experience in the capacity of welding operator, welding foreman and welding and manufacturing engineer.

For the past two years Mr. Miller has been a Sustaining Member of the AMERICAN WELDING SOCIETY and a prominent member of the Syracuse Section for 18 years. He has been a member of the Syracuse Section Board of Directors for 10 years and in 1949 served as Section chairman. For the past three years Mr. Miller has served as chairman of the Finance Committee of this Section.

Mr. Miller is a member-at-large of the Technical Activities Committee and presently serves on the TAC Executive Subcommittee. He is also the AWS representative on the ASA Committee C-87.

In addition to these activities Mr. Miller was recently active in the organization of the newly formed Mohawk Valley Section at Utica, N. Y.

Lew Gilbert
District 5, East Central

Lew Gilbert is the executive editor and general manager of both *Industry and Welding*, a monthly publication, and *Welding Illustrated*, a quarterly publication, and in both connections associated with the Industrial Publishing Group, a division of Telenews Productions, Inc.

Mr. Gilbert has been associated with the AMERICAN WELDING SOCIETY for 16 years. As a member of the New Jersey Section he was active in the affairs of that Section and was, prior to leaving, a member of the executive committee of that Section.

During the time Mr. Gilbert worked in New Jersey, first as chief test welder for the Metal & Thermit Corp., and then later as assistant welding engineer for the M. W. Kellogg Co., in Jersey City, he wrote several articles which were published in national magazines, including THE WELDING JOURNAL. At that time Mr. Gilbert was active presenting papers before various Sections of the SOCIETY. He served as chairman of the National Membership Committee during the 1955–56 membership year.

Presently in Cleveland, Mr. Gilbert has served the Cleveland Section as first vice-chairman, then as chairman and member of the Board of Directors of that Section.

In 1952 Mr. Gilbert wrote the *Pocket Manual of Arc Welding*, a textbook on arc welding.

A. F. Chouinard
District 7, West Central

Alfred F. Chouinard is the manager of the Research and Development Department of the National Cylinder Gas Co., Chicago, Ill., and has been with NCG since 1939. He graduated from Purdue University in 1931 with a B.S. degree in electrical engineering and prior to joining NCG, he held engineering jobs in the fields of mechanical and electrical design. He has had many patents granted in his name.

He has been active in the AMERICAN WELDING SOCIETY for a long time both as a Section and a National Officer. He was the chairman of the Chicago Section in 1951–52, and is currently serving his first term as Director of District No. 7. As a member of the National Board of Directors, he has been appointed as a member of the Technical Council, and also is the chairman of the Section Advisory Committee. He has previously served on many other AWS Committees.

In addition to his AWS membership, Mr. Chouinard is a member of the International Acetylene Assn., American Society for Metals, The American Institute of Steel Engineers, and is a member of the Chicago Engineers Club as well as being a Registered Professional Engineer in the state of Illinois.

Percy V. Pennybacker
District 9, Southwest

Percy V. Pennybacker is a civil engineering graduate of the University of Texas and has completed 34 successful years in bridge engineering including design and supervision of construction. During this period he was employed by consulting engineers, two state highway departments, the U. S. Engineer Office and the Tennessee Valley Authority. For the past fifteen years he has been a supervising field engineer for the Bridge Division of the Texas Highway Department, operating from the headquarters office in Austin.

Mr. Pennybacker is an associate member of the American Society of Civil Engineers, a member of the Texas Society of Professional Engineers and a member of the National Society of Professional Engineers. He is a registered professional engineer.

He joined the AMERICAN WELDING SOCIETY in March 1945 and has been a director of the Houston Section and a chairman of the Austin Division of the Houston Section.

Charles B. Robinson
District 11, Northwest

Charles B Robinson was born in Philadelphia, Pa., in 1906. He is a graduate of the University of California. From 1939 to 1944 he was employed by the Mare Island Shipyard in the capacity of welding engineer. He became associated with Air Reduction Pacific Co. as welding service engineer in 1944 and in 1950 became Supervising Welding Engineer in charge of process engineering.

Mr. Robinson has been a member of the AMERICAN WELDING SOCIETY for 27 years, having joined in 1929. During these years he has served the SOCIETY as Section technical chairman for two years and Section chairman of the AWS San Francisco Section, in 1955. He is also the author of various articles on welding processes and electrodes.

Mr. Robinson is a member of the American Society for Metals, American Society of Naval Engineers, Navy League of the United States and American Ordnance Assn.

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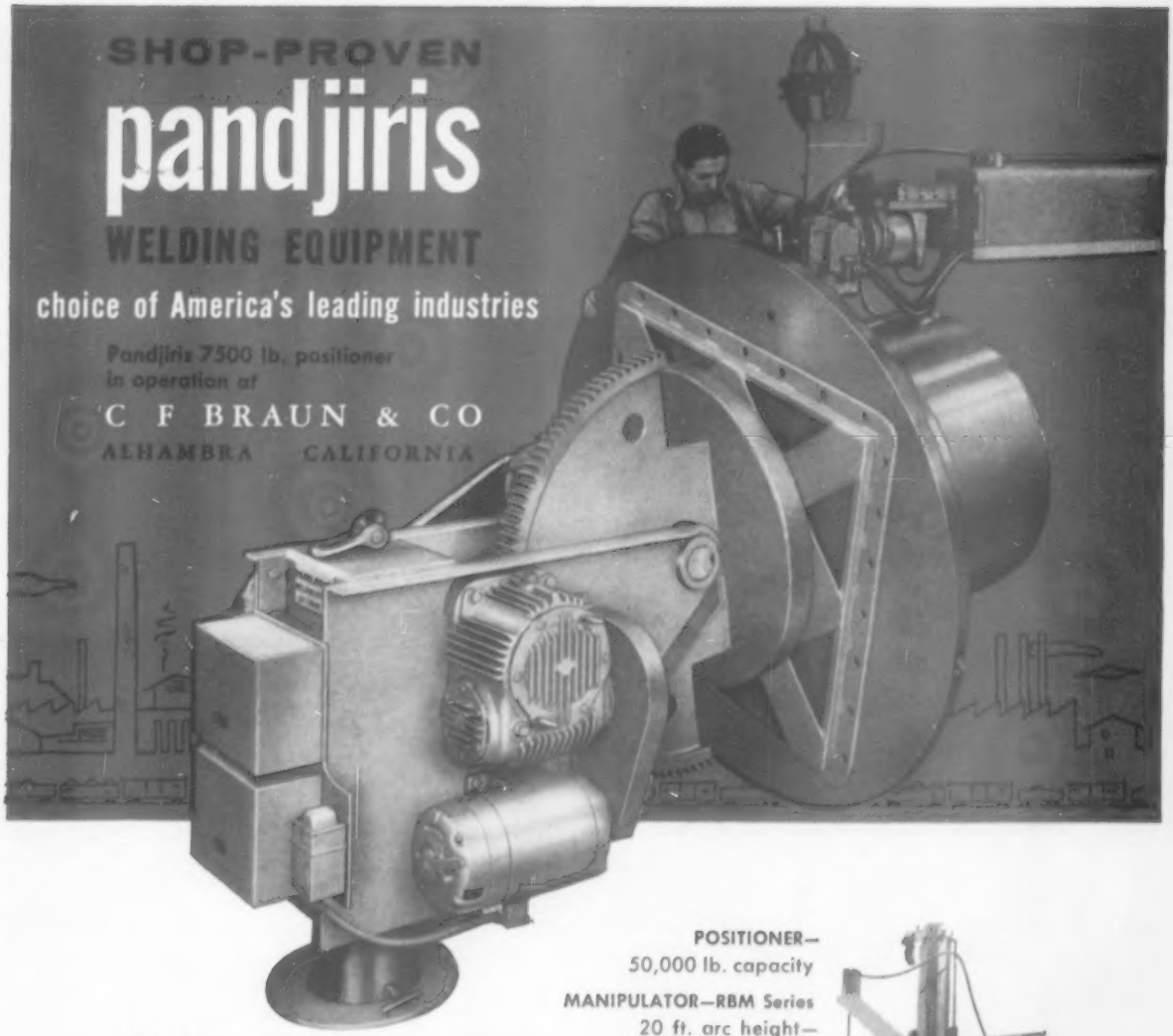

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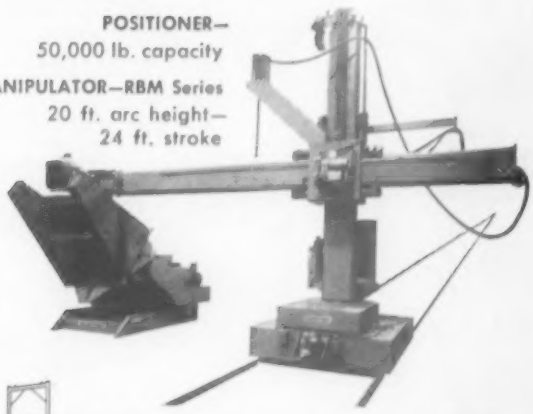

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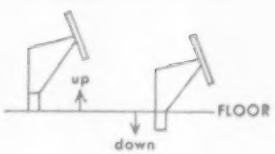

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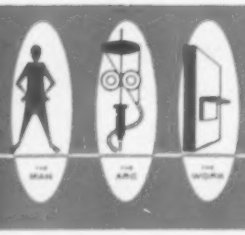

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District Representatives on the National Nominating Committee

The District Nominating Committees have also selected the eleven nominees for District Representatives on the National Nominating Committee which will select the national officers for the 1958–59 term. The names of their candidates are as follows:

District No.	*Nominee*
2	E. E. Goehringer, Lincoln Electric Co., P. O. Box 268, Drexel Hill, Pa.
3	Robert J. Barr, proprietor, Rochester Steel Treating Wks., 962 Main St., East Rochester, N. Y.
4	E. C. Miller, superintendent, Inspection Engineering Dept., Oak Ridge National Laboratories, Union Carbide Nuclear Co., 116 Everest Circle, Oak Ridge, Tenn.
5	E. W. Rowlands, Jr., welding engineer, The Griscom-Russell Co., Massillon, Ohio.
6	J. R. Stitt, engineer, R. C. Mahon Co., P. O. Box 4666, Detroit 34, Mich.
7	Lester L. Baugh, general foreman, Allis-Chalmers Manufacturing Co. (Res.) 1306 E. Lenox Ave., Springfield, Ill.
8	M. L. Powers, Linde Air Products Co., 910 Baltimore, Kansas City, Mo.
9	C. E. Russell, works manager, J. B. Beaird Co., Inc., 6200 St. Vincent Ave., Shreveport, La.
10	S. R. Lanier, chief engineer, Southwest Welding and Manufacturing Co., 3201 W. Mission Rd., Alhambra, Calif.
11	Wallace J. Erichsen, manager, Metallurgical Laboratories, Westinghouse Electric Corp., Hendy Avenue, Sunnyvale, Calif.

●

In accordance with National By-Laws, ballots will be mailed to all SOCIETY members on or before Dec. 26, 1956. Balloting will close on Jan. 26, 1957. Election results will be published in the May 1957 issue of THE WELDING JOURNAL. Elected nominees will officially assume office on June 1, 1957.

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Aronson TracTread (T. M. Reg.) Turning Rolls for thin-walled heavy cylindrical work to 27 tons capacity. Zero to 100 IPM turning speed and Built In Grounding.
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Aronson Universal Balance Positioners (T. M. Reg.) position your weldments effectively, instantly for downhand welding. Capacities to 2000 lbs.
Rugged Head and Tail Stock for positioning bulky weldments between centers. Table Backup for Zero Deflection. Magnetic Braking. Capacities to 160,000 lbs.
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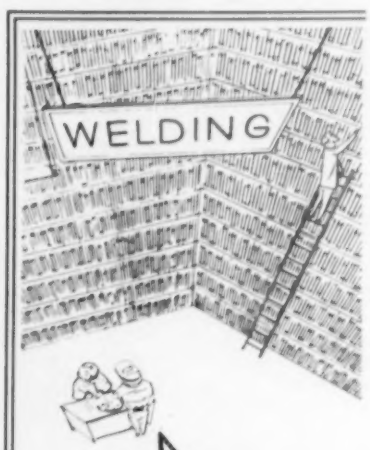

What's New on Welding Space Ships?

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Cracking Problems in Cast Iron Weld Deposits Examined

Production and maintenance welding of cast iron has been practiced for decades. Until recently, it was considered an art requiring considerable welding skill because of cast iron's poor inherent properties. But continued exploration by "Eutectic" has made the techniques of cast iron welding capable of scientific control.

At the National Metal Show, attention was again directed to "Eutectic's" advanced research in this field. Joseph F. Quaas, Director of Manufacturing and Production at "Eutectic," addressed the fall meeting of the American Welding Society in Cleveland, Ohio, on "Aspects of Crack Sensitivity in Machinable Cast Iron Deposits." Mr. Quaas discussed the problems of welding both gray and nodular cast irons. He analyzed various types of coated electrodes, such as 99 per cent nickel, 55 nickel-45 iron, and monel grades, and recounted the incidence and degree of cracking that occurs with these electrodes and with electrodes of various coating formulations. This work helped to perfect the new, non-cracking, high tensile, machinable electrode for cast iron, Xyron 2-25. Hardness surveys, tables on physical properties and chemistry of test blocks, and macro and microphotographs depicting various weld structures were made available to the audience.

Results of "Eutectic's" research and development program are apparent in the newest cast iron electrodes and rods, such as EutecRod 144FC Super, which welds gray and alloyed cast irons at lowest possible application temperatures and produces dense, sound weld deposits, with minimized warping, distortion, stress, and embrittlement caused by conventional high heat cast iron rods. **(A-20)**

"EUTECBOR" #9 PRODUCES "LOW HEAT INPUT," LEAKPROOF WELD

"EutecBor" #9 recently provided an answer to the problem of joining sections of steel tanks without the use of flux, and without fusion of the base metal, so that the joint would withstand Freon gas and pressure of 300 lbs.

Leakproof re-joining of the tank sections was necessary. Conventional welding rods were found unsatisfactory because of their high application temperatures. "EutecBor" #9, embodying Eutectic's "Low Heat Input" process, produced a distortion free and absolutely leakproof joint.

"EutecBor" #9 has excellent corrosion resistance to various atmospheres and many acids. It can be used on steel, cast iron, high chromium and nickel alloys. Fusion of the surface of the base metal is not required. "EutecBor" #9 is very fluid and will flow through a lap joint. **(A-21)**

EUTECROD 1801 SAVES 60% IN PRODUCTION COSTS

A company manufacturing book binding machinery now saves 60% of the cost of manufacturing a component part by using EutecRod 1801.

The company fabricates hundreds of these parts weekly. Instead of machining the part from one piece of stock, the company now uses EutecRod 1801 to join a thin blank of monel to a piece of drill rod. Time required has been cut by 85% over the previous slow and costly method. Practically no finishing is necessary and the bond is strong and ductile.

A low melting, high silver content alloy, EutecRod 1801 has good corrosion resistance. Designed to bond very readily carbon and alloy steels, copper and nickel alloys, its ultimate tensile strength is up to 90,000 psi. **(A-22)**

XYRON 2-25 WELDS "PROBLEM" CAST IRON

Eutectic's cast iron electrode, Xyron 2-25, has again demonstrated its ability to weld "problem" cast iron with no cracks, "leakers," or stress formations.

An Oklahoma manufacturing company tried to repair cast iron cooler heads with many conventional cast iron electrodes. All produced pin holes and water leaks. A Eutectic District Engineer recommended Xyron 2-25, specially designed for cast iron and cast iron alloys. Eutec-Chamfer-Trode was used to gouge out cracks. Grooves were then covered with Xyron 2-25, ground out, and re-welded with Xyron 2-25. After welding, cooler heads were completely free of pin holes and water leaks.

The shallow, uniform penetration and alloying to the base metal of Xyron 2-25 permits easy slag removal and gives high strength welds with maximum machinability. Welders find Xyron 2-25 suitable for all types of cast iron repairs and for joining cast iron and cast iron alloys to steel. **(A-23)**

EUTECTRODE 680 AC-DC SAVES $1000 STEEL WHEEL, AVERTS TWO MONTHS "DOWNTIME"

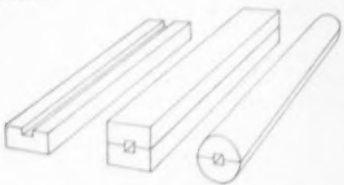
A Eutectic District Engineer's experience and knowledge of welding recently saved a Georgia mining company $1000 and two months "downtime." Damage to a ratchet wheel on an expensive piece of equipment was believed unrepairable and the company ordered a new wheel: cost, $1000; delivery time, at least 60 days.

The company also consulted a Eutectic District Engineer. He advised welding the wheel with EutecTrode 680 AC-DC, a high tensile electrode for very high alloy and carbon steels. EutecTrode 680 AC-DC has a "Frigid Arc" coating which produces a smooth, dense weld, free from porosities. After repair with EutecTrode 680 AC-DC, the equipment was immediately put back to work and the order for a new part cancelled.

Welds of EutecTrode 680 AC-DC have high strength, wear, and impact and high resistance to corrosion and heat. Ultimate tensile strength is up to 120,000 psi. **(A-24)**

EUTEC-TINWELD SOLVES UNUSUAL SOLDERING PROBLEM

A manufacturer utilized Tinweld's easy application and high strength to solve an unusual problem—the fabrication of a die to cut tungsten wire. He first joined two pieces of grooved steel with Tinweld, a paint on solder type paste. Tinweld's good wetting qualities and freedom from spatter prevented any solder from entering the groove.



The square of steel was then turned to a cylinder and heated, the solder removed and the halves heat treated. Tinweld was again used to join the halves. In operation, the die withstands the strain of clipping thousands of pieces of tungsten wire.

Tinweld can be used for all common metals except aluminum and magnesium and is particularly suitable for precision work. **(A-25)**

Eutectic Welding Alloys Corporation
40-40 172nd Street, Flushing 58, N.Y.

Gentlemen:

I would like further free information on the following:

☐ A-20 ☐ A-21 ☐ A-22
☐ A-23 ☐ A-24 ☐ A-25
☐ Free 170 page pocket Welding Data Book.

Name_____

Address_____

City_____ State_____

"EUTECTIC" WELDING HEADLINES • TIME • MONEY • MACHINERY SAVERS

Section News and Events

as reported to Catherine O'Leary

SOCIAL SESSION

Fort Wayne, Ind.—The first meeting of the season of the *Anthony Wayne* Section was a nontechnical social session held on October 17. All prospective members were invited to attend and Falstaff Brewing Corp. was a most gracious host in that they furnished the meeting place and the refreshments.

Chairman Jacob Geiser gave a short résumé of the advantages of membership. A billfold-size card listing the future meetings was distributed to the prospective members.

A film, furnished through the courtesy of Lincoln Electric Co., was shown. The film was a partially animated color film entitled "Weld Distortion." A second film, furnished through the courtesy of the General Electric Welding Department, York, Pa., showed 2500 and 3500 frames-per-minute pictures of inert-gas metal-arc welding.

As a result of this meeting, five new members are practically assured and there are prospects for several more —a good start for the 1956–57 season.

TUNGSTEN-ARC CUTTING

Bridgeport, Conn.—J. S. Douglass [illegible], Manager, Engineering Service, New England District of Linde Air Products Co., Boston, Mass., was the guest speaker at the October 18 meeting of the *Boston* Section held at the plant of the General Electric Co. Mr. Douglass gave a very fine talk on the subject "Tungsten Arc Cutting of Ferrous and Nonferrous Metals" which was illustrated with slides. An interesting question-and-answer period was very ably handled by Mr. Douglass.

POWER SOURCES

Chicago, Ill.—Ninety-two members of the *Chicago* Section were present on October 19 to hear J. E. Lenz' presentation of "What Is a Power Source?" With the aid of simple electrical diagrams, Mr. Lenz explained the operating functions of a-c and d-c welding machines. Various types of controls were discussed, as well as their advantages and disadvantages listed.

The meeting was held at the People's Gas Light & Coke Co.

Dinner at Milner's Restaurant preceded the meeting. Premeeting entertainment was presented by the Illinois Bell Telephone Co. by describing the workings of microwaves and what part they play in communication. The talk was accompanied by visual aids which helped to explain the subject thoroughly.

SECTION MEETING CALENDAR

JANUARY 4

NORTH CENTRAL OHIO Section. Marion, Ohio. Dinner in Plantation Room of Harding Hotel. Tour of Huber Warco Co.

JANUARY 7

LEHIGH VALLEY Section. Plant tour of Parrish Pressed Steel Co., Reading, Pa.

JANUARY 8

DAYTON Section. Dayton Engineers Club, Dayton, Ohio. Dinner meeting. "What Welding Means to America," Ted Jefferson, Editor, *Welding Engineer*.

COLUMBUS Section. Fundamentals Course (through February 28). Ohio State University, Columbus, Ohio. "Nondestructive Testing."

JANUARY 9

CLEVELAND Section. Cleveland, Ohio. Executive Night. Hotel Manger.

SUSQUEHANNA VALLEY Section. Dinner 6:45 P.M. Technical session 8:15 P.M. American Legion, Kingston, Pa. "Joining Aluminum to Dissimilar Metals," K. V. Lutz, All State Welding Alloys Co.

SAGINAW VALLEY Section. 7:15 P.M. High Life Inn, Saginaw, Michigan. "Bridge Welding," William Campbell, Industrial Welding and Brazing.

JANUARY 10

LOS ANGELES Section. Aircraft and Rocketry Panel. 6:30 P.M. Open House, dinner and tour of new Scaky Research Div. Bldg., 2311 Purdue Avenue, West Los Angeles, Calif.

JANUARY 11

COLUMBUS Section. Columbus, Ohio. Educational Series. "Brazing." Columbus Section Panel.

ST. LOUIS Section. Forest Park Hotel, St. Louis, Mo. "Welding and Brazing Problems in Atomic Energy Field," H. S. Kolish, Sylvania Electric Products.

JANUARY 15

NORTHWESTERN PENNSYLVANIA Section. Erie, Pa. "All-Position Iron-Powder Low-Hydrogen Electrodes."

JANUARY 16

PITTSBURGH Section. 8:00 P.M. Mellon Institute of Industrial Research, Oakland. "Large Weldments Fabrication," John L. Lang, Lukenweld Div., Lukens Steel Co., Coatesville, Pa.

JANUARY 17

SHREVEPORT Section. Shreveport, La. "Fire and Earth," R. L. Deily, Air Reduction Co.

JANUARY 18

CHICAGO Section. 7:30 P.M. People's Gas Auditorium, 122 S. Michigan Ave., Chicago, Ill. "Fundamentals of Gas-Shielded Arc Welding," G. R. Rothschild, Airco.

MARYLAND Section. Engineers Club, Baltimore, Md. "Evaluating Iron-Powder Coated Electrodes," Donald B. Howard, American Car and Foundry.

JANUARY 21

PHILADELPHIA Section. Philadelphia, Pa. Past Chairman's Night. "Shop Management for Quality Welding," Lew Gilbert, *Industry and Welding*.

ROCHESTER Section. "Arc Welding of Tool Steel," R. K. Lee, Alloy Rods Co. "No Finer Electrodes Made Anywhere"—Movie.

SAN FRANCISCO Section. El Jardin Restaurant, 26 California Street. "Which Welding Process and Why," O. T. Barnett, Armour Research Foundation.

JANUARY 22

OLEAN-BRADFORD Section. 7:00 P.M. Castle Restaurant, Olean, N. Y. "Welding in Europe," Clarence E. Jackson, Metals Research Laboratories.

JANUARY 25

INDIANA Section Dinner and meeting. Athenaeum Turns Club, Indianapolis. "CO_2 Arc Welding," A. O. Smith Corp. speaker.

MILWAUKEE Section. Dinner 6:30 P.M. Meeting 8:00 P.M. Ambassador Hotel, Milwaukee, Wis. "Structural Welding," Van R. P. Saxe.

JANUARY 30–31

CHICAGO Section. Armour Research Foundation of Illinois Institute of Technology. Mid-West Welding Conference.

Editor's Note: Notices for March 1957 meetings must reach Journal office prior to January 1, so that they may be published in February Calendar. Please give full information concerning time, place, topic and speaker for each meeting.

THIELSCH SPEAKS BEFORE COLUMBUS SECTION

Partial view of audience at October 12th meeting of Columbus Section. Those present heard talk on causes of failures in pipe and pressure vessel joints by Helmut Thielsch

Mr. Thielsch, Roy B. McCauley, section chairman, and Joe Brockmeyer, past-chairman, seated at head table

PIPES AND PRESSURE VESSELS

Columbus, Ohio.—Fifty members of the *Columbus* Section were present on October 12th at the Riverside Rathskeller to hear Helmut Thielsch [M'52], of the Grinnell Co., Inc., Providence, R. I., give an excellent talk on the "Causes of Failures in Pipe and Pressure Vessel Joints."

RESISTANCE WELDING EQUIPMENT

Detroit, Mich.—Some 142 members and guests of the *Detroit* Section were present on September 14th to hear Larry Kendall [M'52], of Fisher Body Division of GMC give an interesting semitechnical talk on the selection of resistance welding equipment. Mr. Kendall is responsible for the selection of resistance welding equipment for more than two dozen Fisher Body Manufacturing plants across the country.

More than 80 members were present for the dinner which preceded the meeting, both of which took place in the Engineering Society building.

THERMAL CUTTING

Glastonbury, Conn.—The second meeting of the season for the *Hartford* Section was held on Tuesday evening, October 23rd, at the Villa Maria Restaurant in Glastonbury. After partaking of a fine steak dinner, Chairman Morton Kenyon conducted a short business meeting.

Following the business meeting, the technical speaker of the evening, Ivar Steen [M'52], of Air Reduction Co., Inc., was introduced. Mr. Steen presented a very interesting talk on the recently developed "Thermal Cutting" process. Illustrated with slides and movies, he gave a very good picture of the use of inert-gas cutting equipment on aluminum and stainless steel.

WELDING METALLURGY

Houston, Tex.—Some 101 members and guests of the *Houston* Section met on September 26th at the Ben Milam Hotel to hear E. L. Hildebrand of the Humble Oil & Refining Co., Baytown, Tex., deliver an excellent talk on "Welding Metallurgy as It Pertains to Low-Alloy Steels and Refining Applications."

RESISTANCE WELDING

Des Moines, Iowa.—The regular monthly meeting of the *Iowa* Section was held on October 18th in the Garden Room of the Kirkwood Hotel. Some 40 members and guests attended the social half hour and buffet dinner which preceded the meeting.

The technical meeting was turned

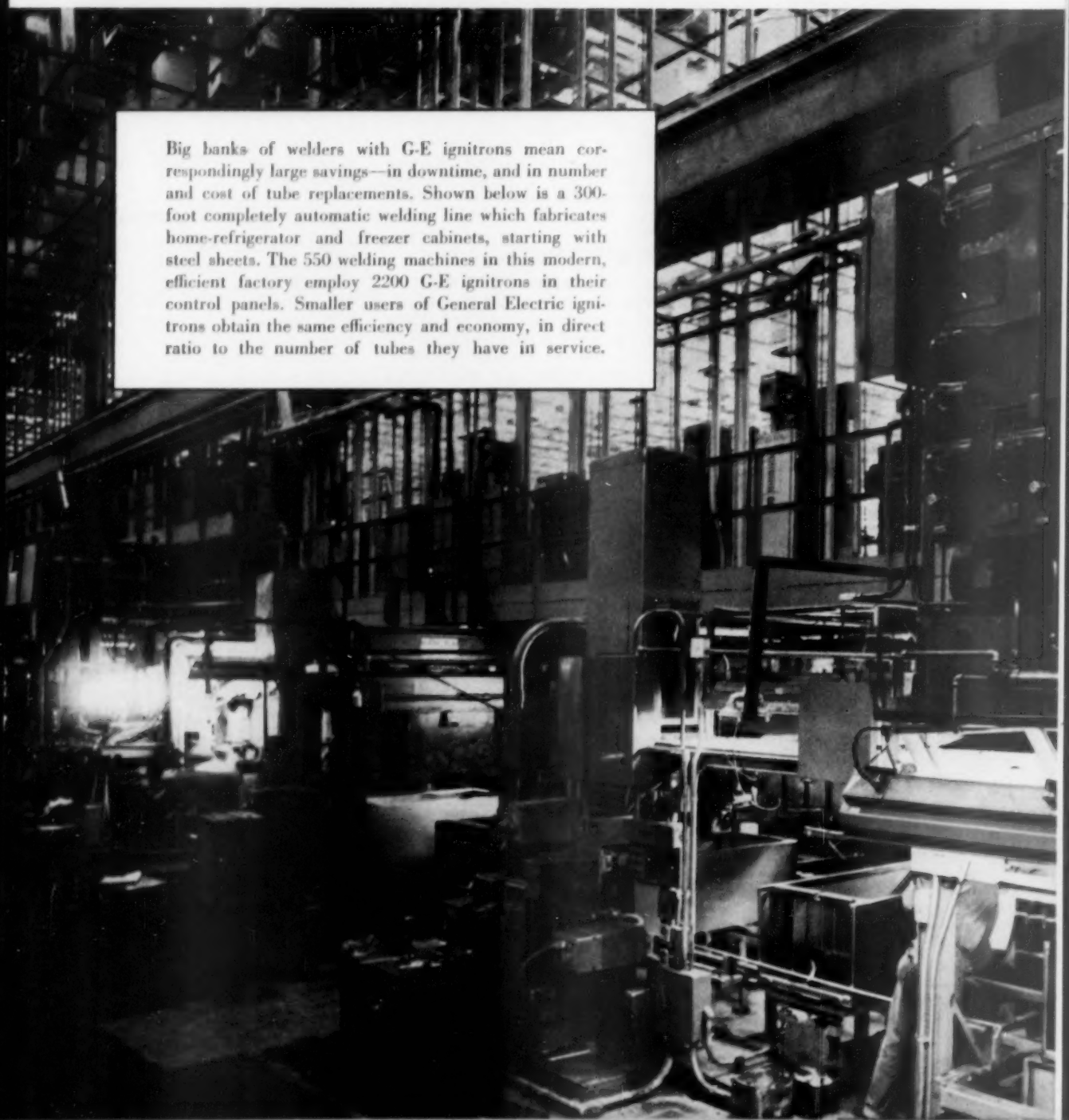
KENDALL ADDRESSES DETROIT SECTION

Part of large dinner group at the September 14th meeting of Detroit Section

Coffee Speaker, Frank J. M. McAllister, who spoke on "Lines—St. Lawrence Seaway"

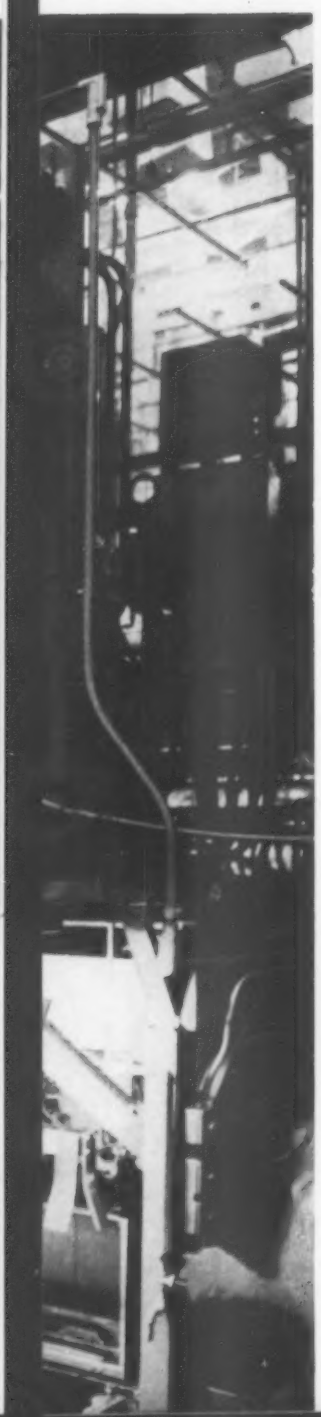
Feature of evening was talk by Larry Kendall on "Selection of Resistance Welding Equipment"

YOUR SAVINGS MATCH THE SIZE WITH GENERAL ELECTRIC'S NEW



Big banks of welders with G-E ignitrons mean correspondingly large savings—in downtime, and in number and cost of tube replacements. Shown below is a 300-foot completely automatic welding line which fabricates home-refrigerator and freezer cabinets, starting with steel sheets. The 550 welding machines in this modern, efficient factory employ 2200 G-E ignitrons in their control panels. Smaller users of General Electric ignitrons obtain the same efficiency and economy, in direct ratio to the number of tubes they have in service.

OF YOUR WELDER INSTALLATION AND REMANUFACTURED IGNITRONS!

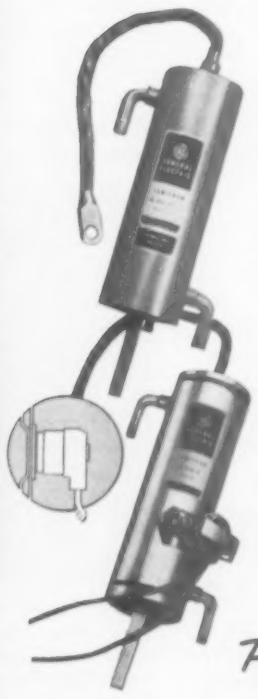


CUT downtime and tube replacement costs! Select your welding ignitron replacements from General Electric's complete line of dependable, long-life tubes! Four different types—each designed to answer a specific welding need—can be obtained from one convenient source, your local General Electric Tube Distributor.

Every G-E ignitron means dollars saved, no matter what the size of your plant. Reliability, trouble-free operation—these qualities slash expensive work stoppages . . . help keep your production lines moving.

Also . . . save 28% on tube replacement costs! Turn in your inoperative G-E ignitrons—if in exchangeable condition—for remanufactured tubes on a one-for-one basis. Get rebuilt G-E tubes with new-tube life and dependability . . . backed by a new-tube warranty. Yet pay up to $63 *less* for each unit you exchange.

To estimate the actual dollar savings G-E ignitrons can bring *you* this coming year, see your local G-E Tube Distributor! *Electronic Components Division, General Electric Company, Schenectady 5, New York.*



G-E Remanufactured Ignitrons get complete new cathode assembly. They give new-tube performance; are backed by standard G-E warranty. Cost $17.90 to $63 less than new ignitrons . . . almost a one-third saving.

General Electric Plastic-coated Convertible Ignitron has a safety plastic covering to shield workers from hazardous voltages. Plastic is red for warning. "Danger . . . voltage" is stamped on. Tube condensation minimized.

G-E Convertible Ignitron has built-in thermal contact bracket to carry a thermostat, for over-temperature protection or water regulation. Either flying-lead or terminal-block thermostat supplied.

G-E Temperature-controlled Ignitron is the finest tube of its kind. Over-temperature control . . . water regulation . . . both are built in. The tube is pre-adjusted at the factory for lifelong efficiency of operation.

Progress Is Our Most Important Product

GENERAL ELECTRIC

161-1C8

LOS ANGELES SECTION ADDRESSED BY CROSS

Relaxing after dinner at the October 4th meeting of the Los Angeles Section are, left to right, Mario Ochieano, John Wiley, Leo West, guest speaker Stanley C. Cross, Howard Eubank, George Murphy and Al Bennett

Speaker Cross shown during the presentation of his paper on quality brazed joints

Leo West presents pen set to speaker Cross in appreciation of the fine paper presented

over to W. J. Farrell, chief application engineer for Sciaky Bros., Inc. Mr. Farrell conducted an excellent discourse on resistance welding applications. Special emphasis was placed on resistance welding to replace castings and forgings. The discussion of resistance welding on heavy steel structures was also of interest to the members. Mr. Farrell augmented his discussion with some very fine film slides of applications.

SAFETY

Allentown, Pa.—A. N. Kugler [illegible], of the Air Reduction Sales Co., New York, in his talk before the *Lehigh Valley* Section on October 1st, outlined the hazards arising from welding and cutting operations; namely:

Fumes from lead painted metals.

The consumption of oxygen in air when burning or welding in confined areas.

Fluorine which may be derived from fluxes and released in atmosphere.

Carbon monoxide from gas-driven welding machines.

Cadmium coated materials may release dangerous fumes.

Beryllium as a constituent in metals is dangerous on contact and to atmosphere.

Fluoride in fluxes can infect open wounds.

Since safety is common sense and the most economical method, the above hazards call for the proper ventilation, respirators or fresh air blowers.

Flames and heat are present in all welding and cutting operations. Therefore, these operations should be confined to a safe area. If the work cannot be carried to this area, then all precautions should be exercised to make the work area unflammable. All degreasing activities should be far removed from welding and cutting operations.

Inert-gas electrodes require darker filter glasses than normal due to the increased ultraviolet arc radiation.

Mr. Kugler closed the technical meeting by reviewing the functions of the AWS Safety Committee and by answering questions from the floor.

The dinner and meeting were held at Walp's Banquet Hall, in Allentown. Coffee speaker was John K. Conneen of the Bethlehem Steel Co. who gave a talk on "Little League Baseball."

BRAZED JOINTS

Huntington Park, Calif.—The October dinner meeting of the *Aircraft and Rocketry Panel* of the *Los Angeles* Section held on October 4th featured a paper on "How to Obtain Brazed Joints for Aircraft and Rocketry Applications."

The paper was presented by Stanley A. Cross, chief brazing engineer for the American Platinum Works of Newark, N. J., before an attendance of 88 members and guests, and was based on a series of development tests conducted at the speaker's plant, and numerous field experiences in silver brazing applications.

Mr. Cross emphasized on how to obtain the best in quality in silver-brazed joints and described, with the use of charts, properties of the various silver alloys and how these properties are used to obtain the most desirable in silver-brazed joints.

Joint designs and the function of a flux, the problems of proper flux selection for the alloys used, including the theory of fluxing, the tolerances and

SPEAKS ON CONTOUR BEVELING

R. F. Helmkamp who presented paper on "Contour Beveling with the Electronic Tracer" before AWS Los Angeles Section members and guests at their October meeting

MARYLAND SECTION MEETS AT USN ENGINEERING EXPERIMENTAL STATION

Large group in attendance at the first meeting of the 1956–57 season held by the Maryland Section at the USN Engineering Experimental Station, Annapolis, Md.

joint design required to obtain the necessary capillary action.

Mr. Cross also described the desirable applications having particular advantages for silver-brazing wire as compared to various other types of silver-brazing filler materials.

A practical and theoretical consideration to the main factors which influence the quality of silver-brazed assemblies, and how to minimize and control defects which occur in the silver-brazed joints, was presented along with the methods of inspection and quality control. The amount of time consumed in the question-and-answer period following Mr. Cross's paper proved beyond doubt that this type of paper covered a well needed subject.

Upon conclusion of his talk, Mr. Cross was presented with a desk pen as a token of appreciation for a well-presented paper and as a memento of the occasion.

CONTOUR BEVELING

Huntington Park, Calif.—Some 112 members and guests were in attendance at the meeting of the *Los Angeles* Section held on Ocotober 18th, which featured a paper by R. F. Helmkamp (M), of Air Reduction Co. entitled "Contour Beveling with the Electronic Tracer." Mr. Helmkamp, a native of Ohio, has been associated with Air Reduction, serving in their Engineering Division since 1919 as a specialist in mechanized welding and cutting equipment, and is identified in the field of all major company developments to date in this line of endeavor.

With the use of slides and a 16-mm movie in color, Mr. Helmkamp was able to present in a descriptive manner the cutting process, what it is, and how it works on cold, hot and alloy materials.

Types and styles of cutting tips and reasons of variations in their uses, type of cut edges such as square edge, double bevel, triple torch operations, V and J bevels and multiple torch cutting. He emphasized on the type of machines and tracers, manual, magnetic and electronic, and the importance of their use in industry.

Mr. Helmkamp's paper proved to be of great interest and was well presented.

Upon conclusion, Mr. Helmkamp was presented with a desk pen by Dave O'Connor, vice-chairman of the Los Angeles Section, in appreciation of the program rendered.

RESISTANCE WELDING MECHANIZATION

Louisville, Ky.—Foster V. Jones, of the Louisville & Jefferson County Air Board, headed the October 23rd meeting of the *Louisville* Section with an interesting talk on "Air Traffic Conditions at Standiford Field." Mr. Jones predicted that in ten years there will be passenger planes of 300,000 lb, and carrying 250 to 300 passengers, that will be able to fly around the world without refueling.

"Mechanization in Resistance Welding," a talk and sound movie, given by F. R. Woodward (M), assistant to the chief sales engineer of the Taylor Winfield Corp., Warren, Ohio, dealt with current design and application of resistance welding machinery to modern industry.

Mr. Woodward is an active member of the technical committees of the American Welding Society, Welding Research Council and Resistance Welder Manufacturers' Assn.

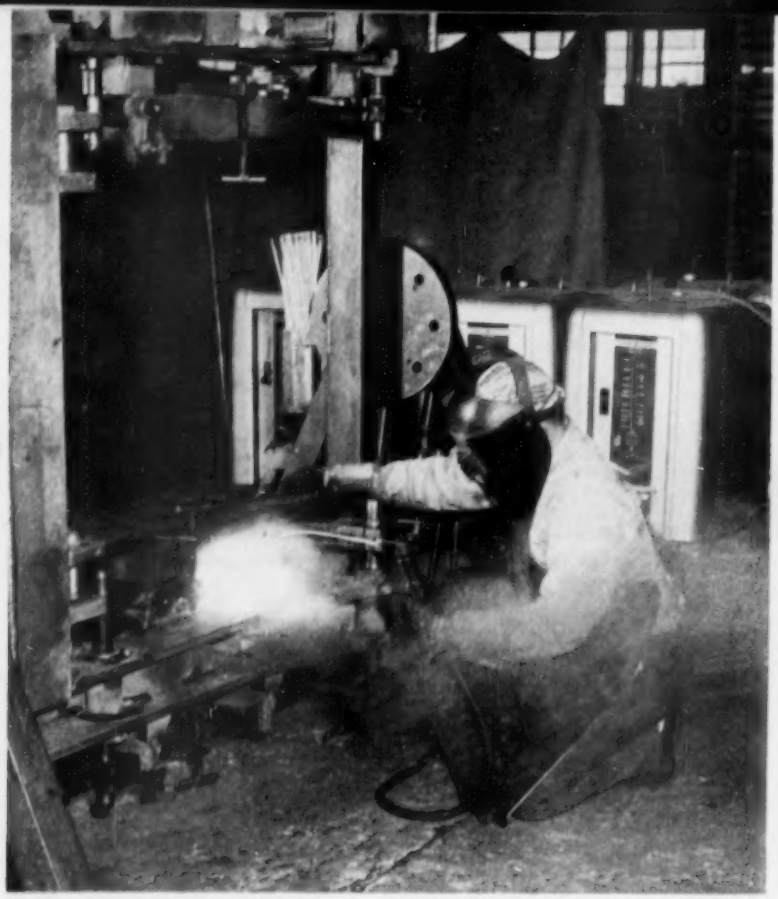
LABORATORY TOUR

Baltimore, Md.—The *Maryland* Section launched the new season with a trip to the Welding Laboratory of the U. S. Naval Engineering Experiment Station at Annapolis, Md., on September 22nd. Welcomed "aboard" by the technical staff of the Laboratory, the group was shown the various facilities of the Laboratory for performing research and development in welding for all the machinery components constituting the propulsion portion of naval vessels, in a $2^1/_2$ hour tour. This included tests for hard-surfacing materials for application to valves in the high-temperature, high-pressure steam lines, welding or piping, superheaters, shafting, propellers and a live demonstration of underwater cutting.

Of particular interest was the simulated-service test equipment for applying cyclic pressure, temperature and thermal shock for evaluating welded joints in piping of differing coefficients of expansion. Facilities were shown for doing this synthetically and by the use of steam. Synthetically, the testing is performed using high-frequency induction heat and built-in arrangements for applying cyclic pressure and thermal shock. For testing full scale mock-ups under thermal shock, using superheated steam in duplication of service conditions, a large steel safety enclosure is provided. The tour through the steel safety enclosure was timely in that the day before, the splitting open of a superheater tube while under 2000 psi and 1000° F provided op-

CONSTRUCTION MACHINERY

Why Clark a-c arc



Using a General Electric a-c arc welder, Alvis Kirk of Clark Equipment Co. welds the hinge plate of a bucket-carrier assembly for a Michigan tractor shovel. Though made for heavy duty, the assembly must be built to a tolerance of $\pm\frac{1}{16}$ inch.

T. E. LYONS, assistant purchasing agent

. . . on a tough

At Clark Equipment Company's modern Pipestone Plant in Benton Harbor, Mich., more than 20 General Electric a-c arc welders are used to weld the Michigan line of tractor shovels and other heavy-duty construction machinery.

This demanding welding job calls for sturdy, stress-carrying welds made to close tolerances. Several difficult positions and many different kinds of steel complicate things further. Why this job was turned over to General Electric a-c welders is explained by four members of Clark's production team:

Alvis Kirk, welding operator—"I like the General Electric a-c arc welder because it's always ready to go. I like the quick-shift range feature which

This clean, sturdy weld, made in a difficult position, binds one of 10 bosses to the hinge plate. The General Electric a-c arc welders easily handle the tough job of welding the plate of hard steel without undercutting the mild-steel boss.

Finished product, the Michigan model 175-A tractor shovel, loads a bin car. In manufacturing this shovel and other heavy-duty machinery at the Pipestone Plant, Clark uses G-E a-c welders.

DIVISION OFFICIALS TELL YOU . . .

Equipment Company uses General Electric welders in building heavy-duty shovels

JACK G. PAUL, welding engineer

NICK J. WHITE, superintendent of maintenance

welding job, G-E a-c welders prove versatile, reliable, economical

allows it to go from high to low current or the reverse, and it's very good about holding an even heat. I must weld vertical-up, vertical-down, and other difficult positions, but I never have any trouble holding a steady arc."

Jack G. Paul, welding engineer—"With the General Electric a-c arc welder there is no arc blow to bother with. Arc striking is instant, and the stepless current control and logarithmic scale give a very fine setting. The large scale in front of the welder enables the operator to see the setting from a distance without leaving his work. And the 'Hi-Lo' range switch quickly adapts the machine to many different applications. The current adjustor on top makes it easy for the operator to set current. In our shop we need machines that keep downtime to a minimum, and General Electric a-c welders meet this requirement."

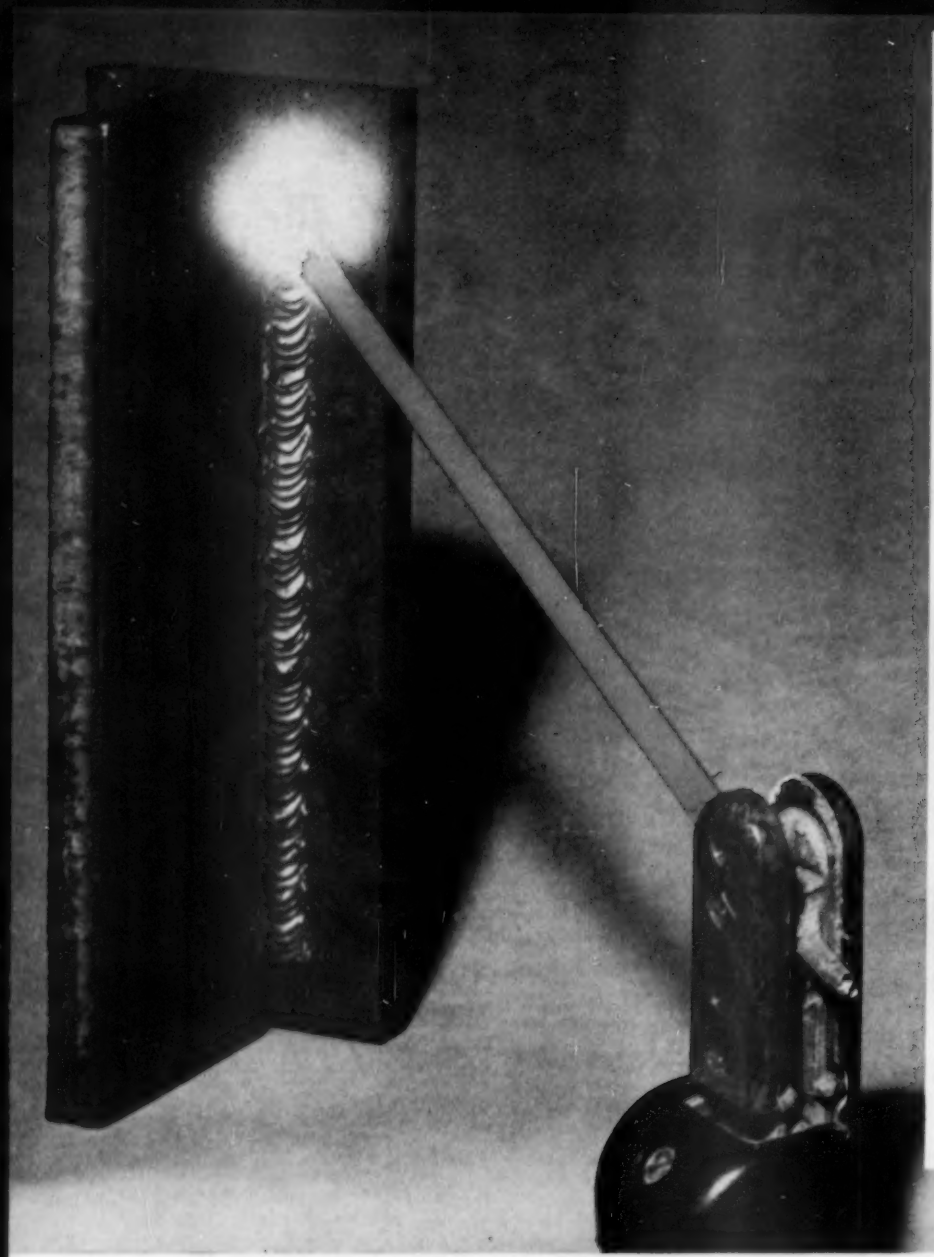
T. E. Lyons, assistant purchasing agent—"I like the General Electric a-c welder because of its ready acceptance by our plant engineers and welding operators. Its price is competitive, and the engineering assistance given by General Electric in applying the welders to solve our various welding problems is invaluable. Delivery of spare and repair parts is excellent."

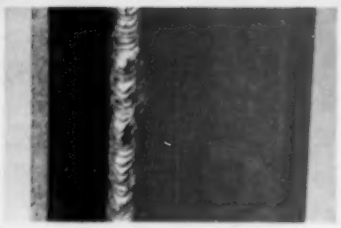
Nick J. White, superintendent of maintenance—"The General Electric a-c arc welder is simple to take apart. We blow out the machines every three months and have had no service difficulties with any of our 20 500-amp machines during the past two years. And, if needed, replacement parts are available on short notice. The electrical switchgear is rigid and heavily built, and the machine has a good ventilation system. Method of power-factor correction on these machines helps us maintain an over-all plant power factor of 88 per cent."

The Pipestone Plant is only one of many users for whom General Electric a-c arc welders have shown their value for heavy-section, high-current welding. If you would like more information on General Electric a-c arc welders, contact your nearby General Electric welding distributor (listed in the yellow pages of your phone book), or write for bulletin GEA-6243A to Section 711-6, General Electric Company, Schenectady 5, N. Y.

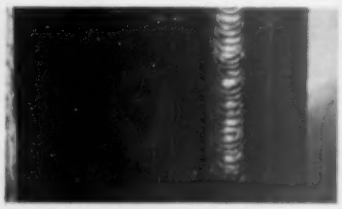
Progress Is Our Most Important Product

GENERAL ELECTRIC

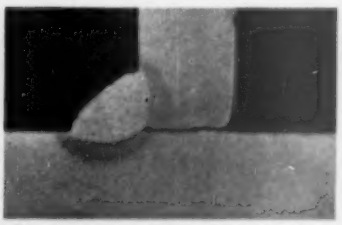




A. Fillet weld using conventional E-6010 Electrode—vertical-up position.



B. Fillet weld using General Electric Strikeasy 610—vertical-up position. Note smoother, more even ripple.



C. Cross sectional view of (a)—note wagon tracks along edges.

D. Cross sectional view of (b)—note flat, even bead—wagon tracks eliminated; no areas for slag entrapment.

NEW IRON-POWDER E-6010 ELECTRODE PRODUCES BETTER WELDS IN ALL POSITIONS

IT'S GENERAL ELECTRIC'S NEW STRIKEASY 610

An E-6010 electrode with an iron-powder coating is now available in General Electric's new all-position Strikeasy 610.

It features:

- Outstanding flexibility, ease of use, and greater deposition rate.
- Excellent wetting action allowing quick and easy whipping technique with greater speed and reduced "wagon tracks."
- Maintains shielding to the full usable length of the electrode.
- Superior bead shape improves ductility, (26% in 2 inches), simplifies slag removal, and improves appearance.

A few of its many applications include tanks, pipe line, steel casting repair, galvanized plates, and ship fabrications.

For more information contact your nearest General Electric welding distributor, or write Section 715-4, General Electric Company, Schenectady, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC

MICHIANA SECTION HEARS FARRELL ON RESISTANCE WELDING

Members of the Michiana Section who met to hear William Farrell, of Sciaky, speak on resistance welding. Mr. Farrell [*dark suit*, center] is shown seated between the section chairman, J. D. Robinson [*left*] and the section secretary, W. G. Fassnacht

portunity to witness the extent of damage caused by such an explosion. This particular test is being conducted to evaluate the cyclic thermal shock resistance of eight designs of superheater tube sealing methods.

In addition, the Laboratory's nondestructive testing facilities were shown which included radiography, ultrasonics, magnetics and oil penetrants. Of interest was a pressure jig which simulates a fine crack for testing penetrants—a test for a test, so to speak.

The group was also guided through some of the Station's other activities and shown facilities for testing diesel engines, fuels and lubricants, various mechanical power plant components, gas turbines and the Station's large metallurgical testing laboratory.

After a $2^1/_2$-hour tour, the group was glad to sit down and see a movie by the ASME Committee for High Temperature Steam Generation showing the design and construction by the Welding Laboratory of an installation for the evaluation of 17 alloys for superheater tubes at temperatures of 1100 to 1500° F at 2000 psi. There were over 5000 welds in the installation which weighed over 40 tons when shipped out to a power plant where the ASME will operate it for the next three years.

The tour concluded with luncheon in a nautical atmosphere at a nearby restaurant, The Captain's Table.

RESISTANCE WELDING

South Bend, Inc.—The *Michiana* Section held its September meeting on the 20th at Russ' Restaurant in South Bend.

"Millions of these welds have been made with no field failure ever reported," so said William Farrell, Chief Applications Engineer at Sciaky Bros., Inc., Chicago, Ill., about spot welding setup on automobile wheels. This was but one of a number of examples cited. The versatility and reliability of various resistance welding processes was the theme of Mr. Farrell's talk, and they were very amply upheld. A graphic description of the four basic resistance welding methods, spot, seam, projection and flash, was given prior to the discussion of the possibilities of cost savings presented by the use of these welding processes.

RESISTANCE WELDING

Milkwaukee, Wis.—The September 21st meeting of the *Milwaukee* Section held at the Ambassador Hotel was devoted to resistance welding. Past-Chairman Jerome B. Welch, process and manufacturing engineer, Cutler-Hammer, Inc., Milwaukee, was the guest speaker. Mr. Welch proved that he is not only familiar with the theoretical considerations, but was also able to give much information on the practical side of shop welding. With his wide experience, Mr. Welch answered many questions and settled many problems.

The members were also fortunate in having President J. J. Chyle, director of welding research, A. O. Smith Corp., as coffee speaker. Mr. Chyle discussed the plans of the AMERICAN WELDING SOCIETY for the coming year, and also gave a report on his recent trip to Spain, where he attended the International Institute of Welding Conference.

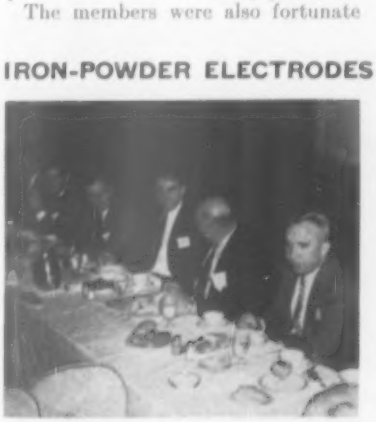
WELDING METALLURGY

Milwaukee, Wis.—"Simplified Metallurgy for Welders and Welding Supervisors" was the subject of a very interesting talk presented by Anton L. Schaeffler (M'42), metallurgist, Welding Research for Allis-Chalmers Co., at the October 19th meeting of the *Milwaukee* Section.

Mr. Schaeffler's talk was unique in that, by using colored diagrams and charts, he was able to present various metallurgical phenomena that occur during welding, in a nontechnical manner, which welders and welding supervisors could easily understand.

More than 100 members and guests

IRON-POWDER ELECTRODES DISCUSSED BY LEE



Head table at the dinner preceding the October 16th meeting of New Jersey Section. *Right to left:* R. V. Thornton, section secretary; J. Hila, chairman; R. K. Lee, guest speaker; N. F. Kiernan, program chairman; and W. G. Benz, treasurer

Speaker Lee is shown addressing the members present on the subject of "All-Position Welding with Iron-Powder Low-Hydrogen Electrodes" The talk was received with a great deal of interest

had dinner at the Ambassador Hotel, and 108 were present at the meeting which followed.

TUNGSTEN-ARC WELDING

Utica, N. Y.—The second meeting of the season of the *Mohawk Valley* Section was called on October 18th in the auditorium of the New York Mills High School.

Technical speaker was Harold S. Davis, process engineer of Air Reduction Sales Co., whose subject was "Gas-Shielded Tungsten-Arc Welding of Stainless Steel."

Gas-shielded tungsten-arc welding employs a nonconsumable tungsten electrode with an inert-gas shield of helium or argon or a mixture of both. The process will deliver peak welding efficiency on material up to $^1/_4$ in. thick that can be welded without filler metal. When filler metal is required it can be introduced into the weld by hand in manual operation and automatically in mechanical operation.

ANNUAL PICNIC

Union, N. J.—The *New Jersey* Section had its annual picnic on September 22nd at the "Old Cider Mill" grove, Vauxhall Road, Union, N. J.

Over 700 members and friends attended the greatest of all picnics held by this section; with due credit going to Picnic Chairman S. L. Sullivan of the Air Reduction Co. Some 120 valuable door and contest prizes were distributed after a continuous round of fun from 12 noon to 7 P.M. The "Guess How Much" gate jack pot of $227.63 was won by C. M. Connelly of M. W. Kellogg Co.

LOW-HYDROGEN ELECTRODES

Newark, N. J.—On Tuesday, October 16th, the *New Jersey* Section held its monthly dinner meeting at the Essex House Hotel in Newark.

Immediately following dinner, a film in color entitled "Fabulous Fishing" was shown. The location was the lakes in the High Andes and the Pacific Coast of South America. The guest speaker of the evening was R. K. Lee (M), of the Alloy Rods Co., York, Pa. His subject was "All-Position Welding with Iron-Powder Low-Hydrogen Electrodes" for all-position work—claiming that vertical welds could be made 44% faster than with the E6010 type, pointing out the easy striking characteristics, elimination of craters and considerably less rework where X-ray quality welds were required.

The long and spirited question-and-answer period indicated the interest of the subject's audience in this well-chosen subject.

WELDING FOR THE AEC

New York, N. Y.—The second meeting of the *New York* Section for the Fall session, was held on Oct. 16, 1956. The program that had been set up for the meeting was very attractive and a large audience was in attendance. Roger Sutton (M), of the International Nickel Co., was the speaker. The topic that Mr. Sutton had selected was "Welding for the Atomic Energy Commission."

Mr. Sutton started by giving the fundamental outline of atomic energy in connection with U-235, continuing with reactor construction and fuel assembly elements. The care by which these parts would have to be welded together was strongly emphasized by the speaker and the test requirements that had to be followed for prevention of failure, were given detailed concern.

TYPICAL SCENES AT NEW JERSEY SECTION PICNIC

At the clam bar

Shot putting contest

Golf contest

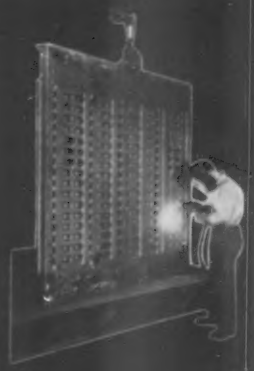
Horse-shoe pitching contest

Casting contest

Sack race

Steve Sullivan, picnic chairman, amidst door and contest prizes

John Hila, *left*, Section chairman, presents jackpot prize to C. M. Connelly



WELDING SOLVES ANOTHER WEIGHT PROBLEM

(and USS "T-1" Steel solves the welding problem!)

Bedplates for modern color-printing presses have to be rugged—but as lightweight as possible. They must withstand constant pounding from printing rollers and cutting knives. And, since they move back and forth continually, they've got to be lightweight for fast, efficient operation. It is a good place to use a welded assembly of steel plate.

But that's where Graver Tank & Manufacturing Co., Inc., ran head-on into a tough fabrication problem. Alloy steel with the necessary strength and durability was difficult to weld. And with 534 welds to make on *every* bedplate, this was a king-size headache.

NO MORE HEADACHE!

Now the headache is gone. Production costs are down. And the finished bedplates are working hard and long . . . taking a tremendous daily pounding without distortion.

The solution? Just a switch to a remarkable *new* alloy steel, USS "T-1" Steel.

"'T-1' Steel is very strong. Very tough. Able to take vicious impact abuse. Yet, it's easy to weld," says Mr. H. McDonald, Superintendent at Graver.

HOW ABOUT YOU?

If you have tough jobs, rugged jobs, where you want to weld your way to lower costs, give this new steel a try. We think you, like Mr. McDonald, will find it the best thing you have ever used. Right now, "T-1" is in service and doing well in bridges, power shovels, steam turbines, electrical transformer tanks, flywheels, pressure vessels, mine cars, and lots of other places. Write for details. United States Steel, Room 5552, Pittsburgh 30, Pa.

"TOP QUALITY" That's how Graver Tank & Manufacturing Co., Inc., East Chicago, Indiana, describes new USS "T-1" Steel. It gives them a yield strength of 90,000 psi . . . exceptional resistance to impact abuse . . . and good weldability. It enables them to build extremely rugged, all-welded bedplates for printing presses.

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UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T1" CONSTRUCTIONAL ALLOY STEEL

USS

6-15

UNITED STATES STEEL

PHILADELPHIA SECTION MEETS AT DREXEL INSTITUTE

Pictured at the September 17th meeting of the Philadelphia Section are [left to right] A. M. Garcia, section chairman; J. J. Chyle, AWS president; Byron Gates, Section vice-chairman, and K. Riddle, Dean of Drexel Institute of Technology

The speaker presented a large number of slides which were very helpful in the talk and gave the audience a very clear picture of the problems involved. The entire presentation was excellent.

The meeting was held at Victor's Restaurant, 1 E. 35th St., New York City, and a good dinner was served prior to the lecture.

It is the belief that with the new location and with the program that has been arranged for the Fall Season, excellent attendance is anticipated.

WELDING IN ACTION

Erie, Pa.—Some 63 members of the *Northwestern Pa.* Section made a tour of the Welded Components Manufacturing Locomotive & Car Equipment Department, General Electric Co., on September 25th.

Preceding the tour, a dinner meeting was held in the General Electric Community Center, and a talk was given by M. F. Lenz of G. E. on the "Fabrication of Locomotive Components."

SELECTION OF WELDING PROCESSES

Philadelphia, Pa.—Drexel night, on September 17th, marked the start of the welding courses presented at the Drexel Institute evening school in cooperation with the *Philadelpha* Section. Many items of welding interest were displayed by local fabricators, including assemblies and parts formed by welding.

The meeting was preceded by dinner at Cavenaugh's Restaurant where Past-President Harry Pierce of the New York Shipbuilding Co. was the guest speaker. Mr. Pierce spoke on the need of technical welding training.

Chairman Gus Garcia opened the meeting with the introduction of Dean Riddle of the Drexel Institute and the staff for the welding courses.

Speaker at the meeting was National President J. J. Chyle, A. O. Smith Corp., who presented a talk on "Factors in the Selection of Welding Processes." This comprehensive evaluation included outstanding features, major applications and some of the limitations of the various welding processes. The subject matter evoked many questions particularly with regard to the role that the welding engineer should play in the design, planning and production of weldments.

There was an attendance of 150 at the meeting and 60 at the dinner.

VEHICULAR TUNNEL TUBES

Philadelphia, Pa.—Sixty-five members of the *Philadelphia* Section attended the dinner meeting held on October 15th at the Engineers Club.

A paper entitled "A New Concept in Fabrication and Launching of Vehicular Tunnel Tubes," prepared by the Welding Engineering Department of Baldwin-Lima-Hamilton, under the direction of F. P. Iapalucci, manager, was presented by C. J. Ascenzi, chief welding engineer. The design of an extremely large underwater vehicular trench type tunnel presented a terrific challenge.

The 6863-ft long tunnel was divided into 23 tubes, each 301 ft 10 in. long, which were made up of 20 shop-fabricated sections, 33 ft ID. The tubes were erected on the bank of the Delaware River, sealed with dam plates at each end, side-launched and towed to the tunnel site. Loading with concrete between inner and outer sections enabled them to sink the tubes into position for final assembly. Length of the completed tunnel was within $\frac{1}{2}$ in. of the design dimensions.

Over 160 tons of electrodes were consumed in 230 miles of welding, which followed 138 miles of oxygen cutting in preparing the plate edge for welding. A total of 52,886 tons of steel and concrete went into the fabrication of this tunnel.

The planning, tooling and preparation for this job as well as the fabrication methods, equipment, launching and final assembly were described in detail by Mr. Ascenzi. W. H. Shire, welding engineer, and Mr. Iapalucci assisted Mr. Ascenzi in answering the barrage of questions following the presentation of an outstanding paper.

FERRITE IN STAINLESS STEEL

Pittsburgh, Pa.—Some 85 members and guests of the *Pittsburgh* Section were present on October 17th to hear a talk on "The Measurement and Calculation of Ferrite in Stainless-Steel Weld Material" as given by W. T. DeLong AWS, chief metallurgist, the McKay Co., York, Pa. Mr. DeLong discussed the effect of ferrite (i.e., the reasons for wanting to know the ferrite content of a weld deposit), the effect of the base metal and various procedures for calculating and measuring ferrite in a stainless-steel weld.

Through the courtesy of Allegheny-Ludlum Co. a film was shown on the "Arc Welding of Stainless Steel."

The meeting was held in the auditorium of the Mellon Institute. The get-together dinner was held in the Hunt Room of the Hotel Webster Hall.

CONTOUR BEVELING

Portland, Ore.—The October meeting of the *Portland* Section was held at Heathman Hotel on October 9th.

After a social period and dinner, a short business meeting enacted the establishment of a scholarship fund and scholarship committee to handle said fund. Members of this committee are Amil Killin, Chairman, Paul Kullburg and Harry Swan.

Speaker of the evening was R. F. Helmkamp AWS, of Airco, who gave a very interesting talk on "Contour Beveling with Electronic Tracers," which was highlighted with motion pictures and slides.

CONTOUR BEVELING

Seattle, Wash.—The October meeting of the *Puget Sound* Section held on

October 11th at the Engineer's Club, Seattle, had as its speaker R. F. Helmkamp AWS, of Air Reduction Co. Mr. Helmkamp delivered an extremely informative technical talk on the subject "Contour Beveling with Electronic Tracers."

Slides and a 16-mm film were shown on the subject and a discussion of other aspects of mechanical gas cutting was held. Some 60 members and guests were in attendance.

PLANT TOUR

Rochester, N. Y.—On October 13th, the *Rochester* Section opened its 1956–57 schedule with a visit to the Bethlehem Steel Corp.'s Lackawanna plant in Buffalo, N. Y. About 100 members and guests traveled by bus and automobile from Rochester and outlying areas.

The tour through the plant by bus included the blast furnaces and converters, the open hearths, soaking pits, plate and structural hot roll mills, and the sheet and strip mills as well as the pickling, straightening and heat-treating operations.

The tour occupied four hours and all who attended indicated it was one of the finest plant visitations the group has made.

CO_2 WELDING

Saginaw, Mich.—Some 108 members of the *Saginaw Valley* Section met on October 4th at the High Life Inn for their regular monthly dinner meeting.

The technical session was highlighted by a very interesting presentation by A. J. Dearing AWS, of the A. O. Smith Corp., Milwaukee, Wis., covering all phases of CO_2 welding such as comparative costs, speed, maintenance and equipment.

Mr. Dearing's ability to stimulate his audience was evidenced by the many questions asked during the question-and-answer session and the individual conferences held after his talk.

CONTOUR BEVELING

Berkeley, Calif.—On October 22nd R. F. Helmkamp AWS, of the Air Reduction Co., addressed the *San Francisco* Section on the subject of "Contour Beveling with the Electronic Tracer." Mr. Helmkamp explained that the basic tools used were gases and tips and the fdunamental objective was the achievement of desired edge geometry. Flame cutting, he explained, is a process of controlled oxidization of the metal while the tip progresses along a predetermined contour. The cutting tip, which is essentially an orifice meter, is the tool that makes it possible to control the kerf. The electronic tracer, using two photo cells to pick up reflected light from the lead spot centered on the edge of the contrasting color template, controls the steering motor through servo equipment and bucking currents from the two cells which balance one another when the lead spot is exactly centered on the tracing edge of the template.

Bevel contours of almost any desired configuration are produced by use of the built-in mechanical features of the equipment.

Templates of tempered masonite and plastic electrical tape are much more easily made and cost only about

SPEAKS ON CO_2 WELDING BEFORE SAGINAW VALLEY SECTION

Guest speaker A. J. Dearing [*second from left*] of A. O. Smith Welding Institute answers one of Joe Stanulis' [*far right*] questions, while Godfrey Burrows [*left*] and Fred Williams [*second from right*] listen intently

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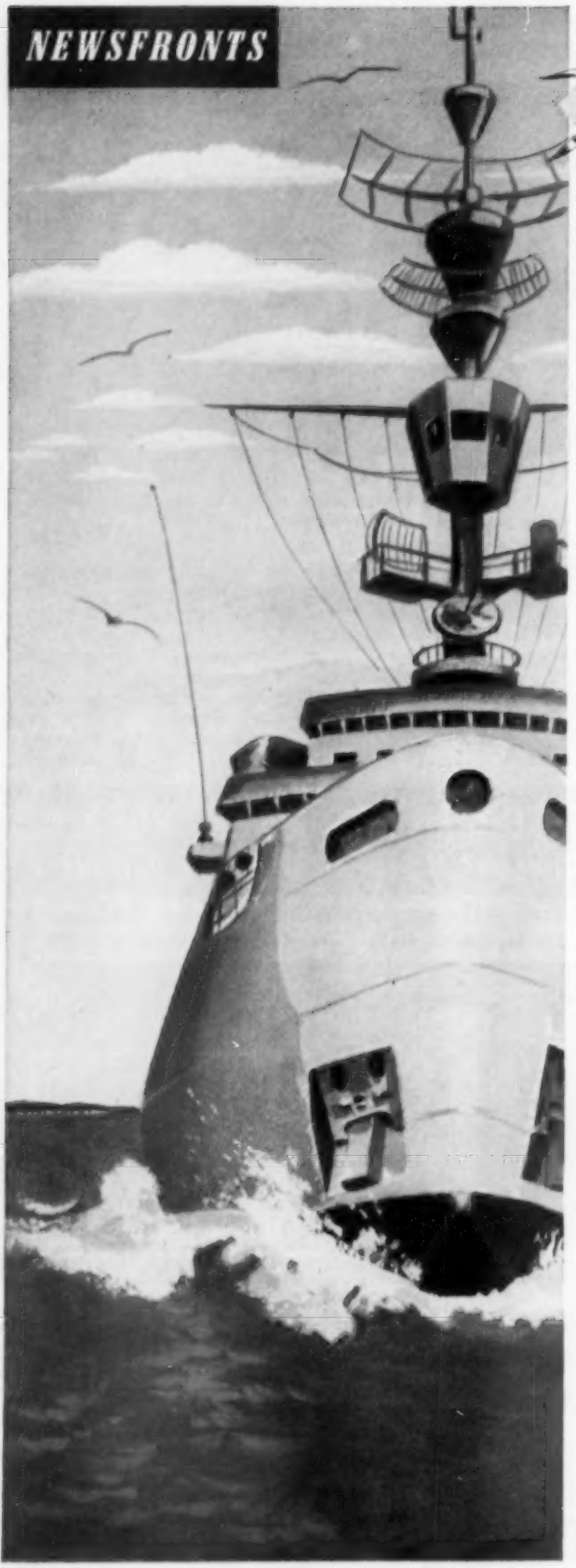

Smooth sailing here...

Ordinary ... snap like

Thus, to build the country's largest and most powerful ice-breaker, Ingalls Shipbuilding used dependable A. O. Smith SW-65 and SW-120 welding electrodes

Plowing through Antarctic ice fields, the U.S.S. Glacier encounters and smashes ice 16 feet thick! Imagine the terrific pounding hull welds must take. What's more, temperatures get so low ordinary welds lose their strength, become brittle, snap like match sticks.

To avoid weld failures and to get welds of unusually high ductility, Ingalls Shipbuilding Corporation, Pascagoula, Miss., used A. O. Smith SW-65 (E-6016) low hydrogen electrodes on the hull. They are ideal for withstanding great temperature variations. SW-120 (E-12015) low hydrogen electrodes were used on the special tensile steels.

In addition to "building-in" the strength and other desired characteristics, these electrodes

The man from A. O. Smith... Mr. Cliff Wyatt is the A. O. Smith welding distributor who worked with Ingalls. Cliff Wyatt heads up one of the largest welding supply firms in the country and is ready and eager to help you with any of your welding problems.

PRODUCED BY WELDERS — FOR WELDERS — Because welding is our full-time business, we offer you America's finest welder-proven electrodes, machines and accessories.

but way "down under"...

welds... match sticks

also proved easy to use... helped Ingalls keep welding costs in line.

With A. O. Smith you, too, can get the right electrodes to do your welding job better, faster and at lower overall costs. Your man from A. O. Smith will be pleased to show you why. Contact him today.

The U.S.S. Glacier, one of the ships in the Navy's "Operation Deepfreeze," smashes ice up to 16 feet thick. It does so by riding up over the edge of the ice, pushing forward until the weight of the ship forces the ice to give. There's no room for anything but welds of exceptional strength.

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10% of the metal magnetic tracing templates which the electronic tracer replaces.

S. A. Cross, Jr. [illegible], brazing engineer, American Platinum Works, gave a coffee talk on the fundamentals of silver brazing to the 85 members and guests assembled at Spengers Fish Grotto.

JOINING BY BRAZING

San Jose, Calif.—The first meeting of the *San Francisco* Section for the new year was a very successful one. It was held on September 25th at the Mary Ann Gardens at San Jose, with 85 members at the dinner and meeting. The Section considered itself very fortunate in having as its speaker Harry Lewis, partner and general manager of the Pyromet Co. of San Francisco.

Mr. Lewis' talk centered on applications of electric-furnace brazing of steel, stainless steel, copper alloys and heat-resisting alloys in controlled atmospheres, with various applications of induction brazing being covered. Emphasis was placed on new developments brought about through the requirements of the electronic, aircraft and guided missile industries.

SOCIETY MEMBERSHIP

Shreveport, La.—P. V. Pennybacker of the Texas Highway Department, Austin, Tex., and Director of District No. 9, was the speaker at the October 18th meeting of the *Shreveport* Section held at the Caddo Hotel. Mr. Pennybacker spoke on the benefits received through membership in the American Welding Society.

PLANT TOUR

Toledo, Ohio.—There was a meeting of the *Toledo* Section on October 16th consisting of a plant tour through the National Supply Co., Toledo, Ohio. The tour was preceded by a short discussion of the National Supply Co.'s history and operation by Robert Etnyre, works manager of the Toledo Branch.

The members saw multiple-flame cutting using an electronic tracer, submerged-arc welding, automatic hard surfacing, power-house weldment preparation and welding, machining and heat treating. In this up-to-date Toledo company, they saw where welding has replaced castings, where it is used with castings and where it is used to repair defective castings.

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HI-AMP®
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ELECTRODE HOLDERS
—no wonder then, that thousands of actual users have switched to HI-AMP — they quickly discovered, through experience, that you can't beat a HI-AMP Electrode Holder, regardless of model, when it comes right down to practicability, performance and economy in maintenance.

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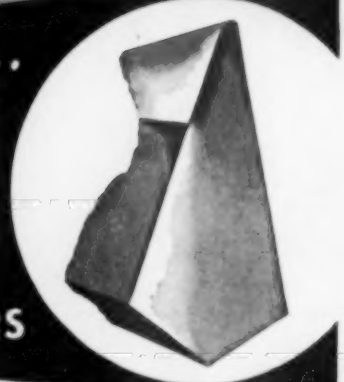

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1. 14 to 18 foot bars mean less scrap from cutting.
2. Nickel in analysis means ease of fabrication — can be bent hot or cold.
3. Hot rolling process means uniform section, denser grain structure, longer wear, freedom from defects common to castings.
4. Bulge behind point where you need it; more metal there, longer wear.
5. Long lengths for bucket lips, grizzly bars, etc.

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The need for production planning and topnotch quality control was evident and is in continuous operation in this plant

Seventy members and guests attended this tour and all seemed to be very pleased with what they saw and heard. Groups were kept small to allow for more questions.

ARC WELDING ELECTRODES

Washington, D. C.—There were 55 members of the *Washington* Section present on September 25th to hear an excellent talk on the history and development of arc welding electrodes, given by Julian Kobler, of the U. S. Naval Gun Factory.

Mr. Kobler gave a short history of the development of the arc-welding electrode. The rest of the talk was devoted to a discussion of the coating constituents of the E45XX, E60XX stainless steel types and low-hydrogen type electrodes. The purpose of each coating constituent and how it influenced the operating characteristics of the electrodes was especially well presented.

Dinner and meeting were held in Naylor's Restaurant. Coffee speaker was Samuel Bryant of Lee, Inc.

TUBE-TURN

In small piping too you get big savings by welding

Five years ago, the generally accepted practice among engineers and contractors was to weld non-critical pipe larger than 2-inches and thread the smaller sizes. Today, that dividing line has gone down; much piping as small as ½-inch is now being welded. In small piping as in large, the big reason for welding is *to save money . . .* in installation cost, in material cost, in maintenance cost. See next page for typical results. For the small pipe jobs, too, you get the *most for your money* when you specify and buy TUBE-TURN* Welding Fittings and Flanges. Your nearby Tube Turns' Distributor can give you speedy service in sizes from ½-inch to 42 inches!

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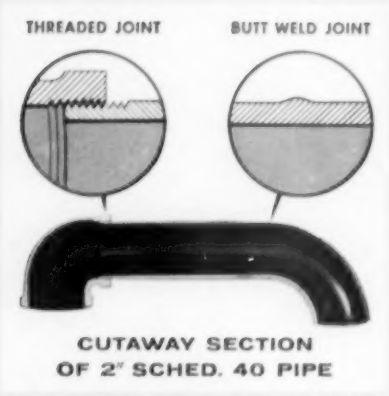
WHY IT PAYS...

SMALL DIAMETER PIPING... *why it pays to specify welded construction with* TUBE-TURN *Fittings*

NEVER LEAKS. Welded joints are permanently as strong and leakproof as the pipe itself. Photo shows welded lube oil lines for one of four diesel engines, replacing threaded lines which leaked. If welded in first place, would have saved $4000 replacement cost. Pipe is 2½" with TUBE-TURN Fittings.

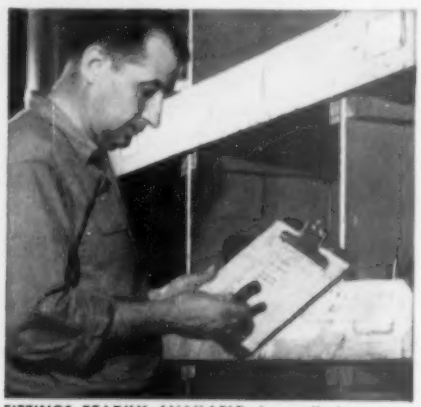


SAVES MATERIAL. Threading cuts half of pipe wall away as shown. The welded joint is as strong as the pipe. An installation of Schedule 40 pipe, welded, is stronger than Schedule 80 threaded. Hence, for equal strength welded piping can cut material costs 30-50%.

TAKES LESS TIME to weld than to thread pipe above 2" and about equal time for smaller sizes, according to recent tests on hundreds of joints made by many different pipe fitters. Welded joints in 1½" piping such as the school heating line shown, averaged 7 minutes compared to 8 minutes for threading and tightening fitting.

IS COMPACT, NEAT. This installation of 1½" and 2" boiler blow-off piping shows ability to nest welded lines close together for better layout and streamlined appearance. Also, insulation, where needed, is easier to apply.

TOOLS ARE SIMPLE. Small, inexpensive welding outfits can cut, weld, heat to bend, solder or braze. They are easy to haul to job and simple to use. All pipe for this factory radiant heating system was fabricated on the site.



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MORE INFORMATION—This bulletin gives helpful information on "The Economics of Welding Small, Noncritical Pipe". Mail the coupon for your free copy.

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PLANT TOUR

Holland, Mich.—On October 22nd, 71 members of the *Western Michigan* Section took part in a tour of the plant of the Roamer Boat Division of the Chris Craft Corp. where steel pleasure crafts are manufactured. This was a very enlightening and enjoyable tour. Michael Potter related the history of the company before the tour.

INERT-GAS WELDING

Worcester, Mass.—A dinner meeting of the *Worcester* Section was held on October 1st at Nick's Grille. Speaker of the evening was Robert Starr of the Air Reduction Co. whose subject was "Inert-Gas Welding Procedures." Drawing from his experience at the Murray Hill Laboratory of Airco, he described the possibilities, prospects and limitations of argon, nitrogen and CO_2. Following his address, a film was shown entitled "Whatever We Do" which shows how oxygen and various gases are separated from the atmosphere and processed. Then it shows how these gases are applied in a large number of industries. Also shown was a General Electric film on "Automation." Both films were very interesting and instructive.

SAFE HARBOR DAM

Safe Harbor, Pa.—The *York-Central Pennsylvania* Section held its monthly meeting on Sept. 11, 1956, at Safe Harbor Dam, located east of York on the Susquehanna River. The group was served dinner in the dining room of the Safe Harbor Water Corp. after which Walter W. Lilly, chairman, conducted a brief business meeting.

P. M. Hess, manager of the installation, discussed the construction and operation of the dam which was completed by private enterprise in 1931. Its construction required almost 30,000 tons of structural and reinforcing steel and over 500,000 cu yd of concrete. Its length is 4869 ft with a forewater of ten miles. The installed capacity is 230,000 kw. Energy is supplied by the Susquehanna River, which stretches for 448 miles from Cooperstown, N. Y., to the Maryland tidewater.

Mr. Hess noted that a preventative maintenance program for the seven turbines has been established. A necessary part of this program is the welding repair of cavitation defects which develop in the cast stainless blades and wicker gate assemblies.

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Following the discussion, W. B. Hess [M], mechanical engineer, conducted the group on a tour of the installation. The highlight was seeing the interior of a scroll case, wicker gate and blade assembly of a turbine that was open for its yearly inspection.

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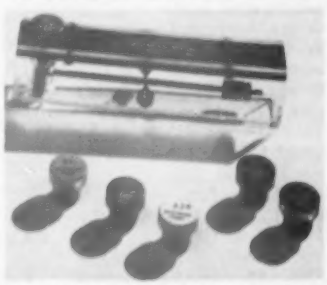

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Hila, John (C to B)

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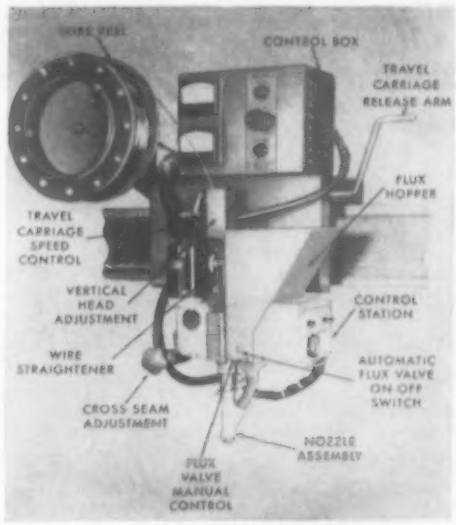

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Wire. Wrought Aluminium and Aluminium Alloys for General Engineering Purposes—Wire. Brit. Standards Instn.—Brit. Standards, no. 1475 (1955), 29 pp.

HOME VIEW OF CABLE AS TOLD BY A BABY

Now, folks, you may not think I'm the happiest kid in the world from looking at my picture here, but you ought to see me light up when my Dad comes home. Boy, he's just about the best Dad in the whole wide world. Or as Dave Garroway would say, the whole wide, wide world.

He grabs me up the first thing when he comes in the house and tosses me way up in the air. I'm not afraid a bit, 'cause he always catches me real easy like. Mom comes runnin' in and he gives her a big hug and kisses her right on the mouth. I don't understand what gets into grown folks kissin' like that, but they seem to like it and I like to see them happy.

It wasn't always like this either. In fact, it was only a short while ago that Dad just wasn't much fun. He'd come draggin' home in the evening and hardly had a smile for me, let alone a big toss in the air. Oh, he kissed Mom all right, but it was hardly more than a little peck, and neither one of them seemed to get much of a kick out of it. He was takin' them vitamins and things but they never seemed to do him much good.

Then a few weeks ago things really got better. Dad began coming home just like I told you in the beginnin', with lots of life and energy and gee, he's a lot of fun. I sure didn't know what happened but I was awful glad. Mom noticed it right away and I heard them talkin' about it the other night when I'd just about killed my bottle and was supposed to be asleep.

"You Mean You Haven't Heard About Tweco-Lite!"

I guess I should of told you right off the beginnin' that Dad has a real important job welding in one of the car factories. He's always liked it a lot but it's real hard work and he was usually worn down by nighttime.

Like I was sayin', he and Mom was a talkin' the other night. She was real happy and tellin' him how much more energy he seemed to have now.

He was sayin' he had a real smart boss and the other day he came in with a new thing for the weldors to use. I don't know nothin' about, but I think the name was Tweco-Lite. I was awful sleepy, but that's what it sounded like. Whatever it is, I sure am glad.

If you, too, haven't heard about Tweco-Lite Aluminum Welding Cable, write Tweco Products, Inc., Box 666, Wichita, Kansas, for the complete story.

ABSTRACTS OF CURRENT PATENTS

prepared by Vern L. Oldham

Printed copies of patents may be obtained for 25¢ from the Commissioner of Patents, Washington, D. C.

2,763,923—Method of and Transition Member for Weld Uniting Dissimilar Metals—Thomas Basil Webb, Beckenham, England, assignor to Babcock & Wilcox Co., Rockleigh, N. J., a corporation of New Jersey.

This new method is on the joining of an austenitic steel member to a ferritic steel component of the structure. The method includes forming a tubular transition member having an internal diameter less than that of the components. Metal is removed from the inner surface of this tubular transition member to remove metal from the root of the weld and increase the internal diameter to that of the other components and fusion welding the austenitic steel tubular component to the austenitic steel piece of the transition member, and the ferritic steel tubular component is fusion welded to the ferritic steel portion of the transition member. Initially it will be seen that the tubular transition member is made up from pieces of tubular austenitic steel and tubular ferritic steel.

2,764,426—Welding Ring with Nubs Removable by Striking—Robert H. von Ahrens, Elizabeth, N. J.; Dagny A. Ahrens, Elizabeth, N. J., executrix of said Robert H. von Ahrens, deceased.

The present patent relates to a welding ring including an annular metallic member having a cylindrical outer face, and a plurality of nubs are welded to such outer face and extend radially outwardly therefrom. The nubs are aligned circumferentially so as to space the ends of two tubular members into which the ring is inserted to provide a gap for the reception of the welding rod when the tubular members are welded to each other. The nubs have a rounded inner end welded to the annular member to facilitate their removal after the tubular members are assembled on the annular member.

2,764,668—Process for Electric Arc Welding in a Protective Atmosphere — Louis Dumoulin, Saint-Maude, France, assignor to L'Air Liquide, Societe Anonyme pour l'Etude et l'Exploitation des Procedes Georges Claude, Paris, France.

The present patent relates to a gas-shielded arc-welding method employing two electrodes, respectively, connected to two opposite polarity terminals of an alternating current welding source. The electrodes are maintained in arcing relationship with a common work piece that has an electron emissivity substantially different from that of the electrodes at the welding temperature. The patent particularly relates to the employment of a welding current source having approximately the same open-circuit voltage as would normally be used for similar welding operations where only one electrode is provided. A capacitor is maintained across the welding electrodes and it has sufficient capacity to form with the welding current source an oscillatory circuit capable of producing strong voltage peaks. Thus are reignition after each current alternation is greatly facilitated.

2,764,669 — Welding Electrode Holders—Samuel O. Jones, Newport News, Va., assignor to Newport News Shipbuilding and Dry Dock Co., Newport News, Va., a corporation of Virginia.

Jones' patent relates to a specialized electrode holder and to the novel jaw and handle means provided therein.

2,765,245—Method of Making P-N Junction Semiconductor Units—Albert C. English and John B. Seabrook, Lynn, Mass., assignors to General Electric Co., a corporation of New York.

This patent relates to a method of making P-N junction units and the method comprises preparing a melt including a semiconductor such as germanium or silicon and which includes an electrically significant impurity therein. The melt is deposited in a liquid state and at a temperature less than 85% of the absolute temperature melting point of the semiconductor material therein upon the surface of a solid semiconductor body which has a predominance of conduction carriers therein whose polarity is opposed to that induced by the impurity element in the melt.

2,765,394—Method and Machine for Cutting Metal—Charles G. Griffith, San Diego, Calif., assignor to Rohr Aircraft Corp., Chula Vista, Calif., a corporation of California.

Griffith's patent relates to a special electrode means for transmitting high-frequency electrical discharges to a metal workpiece to disintegrate the narrow portion of the workpiece by high-frequency electrical discharges. The electrode comprises a long strip of flexible metal whose thickness is substantially less than its width. The lower portion of the electrode strip is freely exposed and can be lowered within arcing distance of a workpiece. A thin metal plate is attached to the metal strip electrode so that an energized conductor can be connected to this plate to supply high-frequency electrical impulses for the electrode.

2,765,395—"Electrical Connector for Welding and Riveting"—Clarence F. Kurth, Wauwatosa, and Kenneth D. Purdy, Milwaukee, Wis., assignors to Allen-Bradley Co., Milwaukee, Wis., a corporation of Wisconsin.

In this patent, a special electrical connector for resistance welding is provided. The connector includes a plurality of wedge pieces and a main body, all of which are made from material of high electrical conductivity. The work piece is adapted to be inserted between the wedge pieces and be clamped therebetween but to be readily releasable therefrom. Electrical energy can be passed through the main body and wedge pieces to the workpiece for welding action.

2,766,360—Flux Hopper Arrangement for Submerged-Arc Welding — George G. Landis, South Euclid, and Harold S. Payne, Cleveland Heights, Ohio, assignors to Lincoln Electric Co., Cleveland, Ohio, a corporation of Ohio.

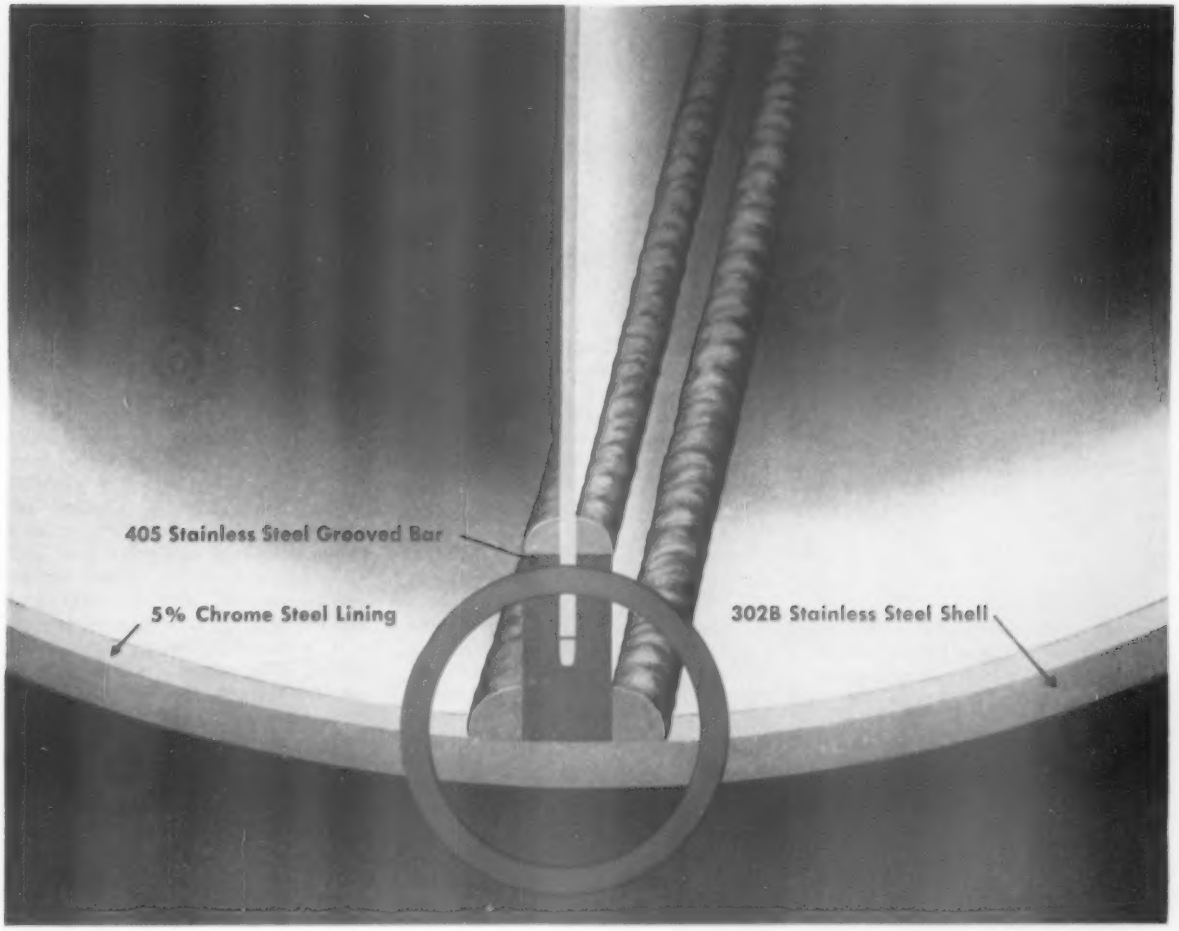
The electric arc welding apparatus includes a flux hopper having a passage at the lower end thereof through which flux flows for deposition onto a workpiece. Valve means are provided in this passage for controlling the flow of flux. Other means that are operatively associated with the feeding of the electrode toward the workpiece are provided for opening this valve means.

2,766,361—"Control System for Arc-Welding Apparatus"—George G. Landis, South Euclid, and Harold S. Payne, Cleveland Heights, Ohio, assignors to Lincoln Electric Co., Cleveland, Ohio, a corporation of Ohio.

In this apparatus, an electrode is adapted to be continuously advanced toward the workpiece. Means are provided for driving the electrode through an electrode nozzle toward the workpiece. Other means are provided and are operative whenever the arc-welding current is broken to reverse the electrode drive means for moving the electrode back through the nozzle a predetermined distance.

Correction:

On page 951 of the September 1956 issue of The Welding Journal, *the Patent number given as 2,748,528 should have read 2,749,528.*



Inco-Rod "A" welds 3 steels at one joint!

Salvages vessel with cracked welds

The vessel you see above was originally designed for 302B Stainless Steel Shell . . . 5% chrome steel lining . . . 5% chrome grooved bars to hold a baffle plate in position.

Trouble developed when these grooved bars were welded into the vessel. Despite preheating, a Zyglo test revealed cracks all along the joint. Weld repair was hopeless.

Then someone suggested an ingenious solution: *Substitute 405 Stainless Steel grooved bars. That way you eliminate the need for preheat. Then use Inco-Rod "A"* electrode to weld the 405 to both 302B shell and 5% chrome lining.*

It worked like a dream! Inco-Rod "A" electrode joined the *three steels* with strong, sound, crack-free welds!

Do you need to weld dissimilar alloys? Ferritic or austenitic stainless steels, low alloy or mild steels, high nickel alloys, copper-nickel or other alloys? Then try Inco-Rod "A". . . the electrode with the green flux coating . . . because it gives strong, ductile, corrosion-resisting welds . . . of X-ray quality.

You'll like the way Inco-Rod "A" electrode *handles*, too. It's operable in all positions. Gives spray-type arc . . . easy slag removal.

Write Inco and ask about the dissimilar alloys *you* want to weld. Our welding specialists constantly bring new data about Inco-Rod "A" electrode in from the field . . . and this information may provide a ready answer to your welding problem.

*Trademark of The International Nickel Company, Inc.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO-ROD "A" electrode is supplied in 14-inch lengths in four diameters, 3/32-, 1/8-, 5/32-, and 3/16-inch (the 3/32-inch is center grip) . . . packed in 5-lb. containers.

INCO **Welding Products** • electrodes, wires, fluxes

NEWS of The Industry

Second World Metallurgical Congress Scheduled for Chicago

Announcement that the second World Metallurgical Congress would be held in 1957 was made at the annual meeting of the American Society for Metals held in Cleveland, Ohio.

The coming World Metallurgical Congress will be staged in Chicago next year, November 2nd to 8th, according to a joint statement by A. O. Schaefer, retiring Society president and W. H. Eisenman, Society secretary.

More than 500 metal scientists from upward of 35 nations of the Free World are expected. Already reservations have been received from 263 conferees in 27 countries. Advance registrations from England number 45. Germany is next with 39.

The first World Congress on metals and metals processing and fabrication was held in Detroit in 1951. Staged in conjunction with the National Metal Exposition and Congress it had an attendance well over 35,000. Of this huge group, 550 were metal engineers from 33 foreign countries.

A series of special industrial plant tours plus a week of high level technical discussions on metal working operations will constitute the congress program. The 39th annual National Metal Exposition and Congress will be held at the same time as the world gathering.

Engineering Awards and Scholarships

The James F. Lincoln Arc Welding Foundation of Cleveland, Ohio, has announced awards in its engineering undergraduate mechanical and structural design competition. Wayne Quinton of Seattle, Wash., received the First Award of $1250. Mr. Quinton, a junior last year in the Mechanical Engineering Department of the University of Washington, designed a small arc-welded air compressor for home use. As further professional recognition honoring Mr. Quinton, the Foundation also granted $1000 in scholarship funds to the Mechanical Engineering Department of the University of Washington.

The awards represented top honors in this annual national competition. A total of 46 awards were made to students in 29 different engineering schools. They were made to engineering undergraduates for their mechanical or structural designs in which arc welding was used. Designs ranged from small machine parts to large bridges.

The Second Award went to the other side of the country, to John Tierney and Karl Bartzsch of New York, who as civil engineering seniors at Cooper Union in New York, designed a welded Wichert plate girder to compare it for savings with an existing riveted girder on a Raritan River bridge. They shared $1000 and Cooper Union received, in their honor, scholarship funds of $500.

Richard Moran of Canton, Ohio, as a civil engineering senior at Georgia Institute of Technology in Atlanta, compared a conventional riveted building frame with a welded rigid frame designed according to the relatively new theory of plastic analysis. He received $500, while the Civil Engineering Department at Georgia Tech received $250 in scholarship funds.

The Lincoln Arc Welding Foundation sponsors this competition exclusively for engineering undergraduates. Its purpose, the Foundation states, is to give students an opportunity for professional recognition through the execution of a welded design of their own imagination and ingenuity. A similar competition is being sponsored for the current school year.

Training Services Available Through U. S. Department of Labor

The Bureau of Apprenticeship in the U. S. Department of Labor, Washington, D. C., is a service agency charged with the responsibility of stimulating and encouraging American industry in every way possible to develop and conduct training systems that will meet skilled worker needs and production requirements.

Specifically the agency provides the following consulting services:

1. Assistance in determining training needs.
2. Aid in organizing training throughout a plant to meet production requirements.
3. Technical assistance in the solution of special training problems.

As a service agency the Bureau conducts research studies of the need for skills in the nation's economy and the extent to which management, labor, government agencies and individuals are taking steps to develop necessary skills.

It endeavors to make the public aware of the need for training, to publicize outstanding training systems and to encourage business enterprises, labor organizations and individuals to take appropriate action to insure an adequate number of skilled workers.

It encourages national organizations to adopt policies and procedures that will create a favorable climate for the development of apprenticeship and skill improvement training systems.

It works with management, labor unions, state apprenticeship and community agencies to develop the organizational machinery for training, and to provide technical information and assistance to sponsors of training programs and systems.

Through its technical staff, it develops training aids and other techniques to increase the effectiveness of

COMING EVENTS

A Calendar of Welding Activity

AWS National Meetings

1957 Spring Meeting and Welding Show:

April 8–12, Hotel Sheraton, Philadelphia, Pa.

April 9–11, Fifth Annual Welding Show, Convention Hall, Philadelphia, Pa.

ASM

March 25–29, Tenth Western Metal Congress and Exposition, Los Angeles. Congress at Ambassador Hotel; exposition in Pan-Pacific Auditorium.

Midwest Conference

Jan 30–31, 1957, Midwest Welding Conference, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

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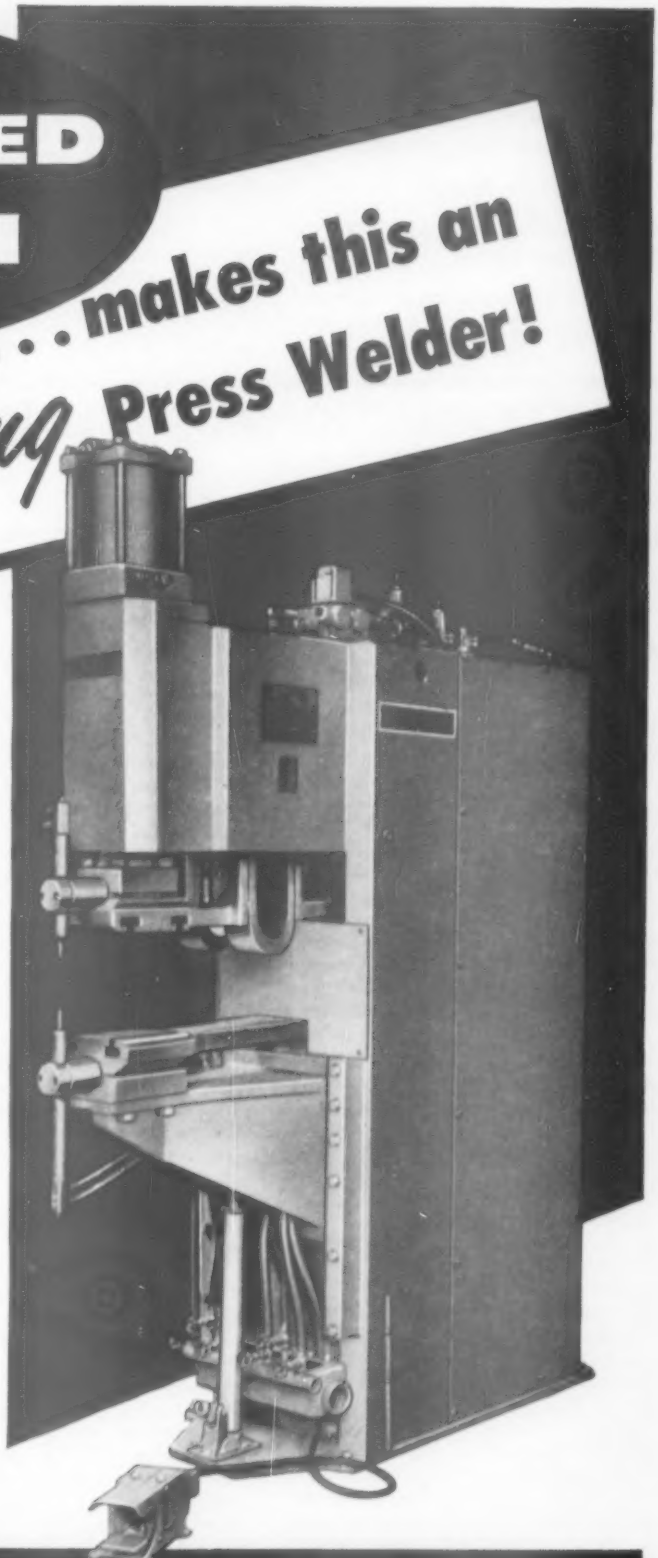

FOR FASTER, EASIER, MORE ECONOMICAL SPOT OR PROJECTION WELDING

- R.W.M.A. sizes 1, 2, 3 and 4.
- Low friction Roller Head.
- NEW, instantaneous follow-up.
- Non-corrosive air cylinder with adjustable stroke deceleration valve.
- Easily adjustable, combination horns and platens. Universal alignment.
- Longer stroke, insulated ram assembly.
- Visible, easily accessible water cooling manifolds.
- Precision alignment, retractable rams.
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- Conveniently mounted controls.

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training and serves as a clearing house for training "know how."

The Bureau's activities are conducted by a small technical staff located in Washington, D. C., and representatives strategically located countrywide.

Stud-Welding Awards Established by Gregory

Gregory Industries, Inc., has announced establishment of a $1500 cash award to be presented annually for the most outstanding contribution to the further development of electric-arc stud welding.

The cash award—or $2000 in scholarships for any individual or school of the winner's choice—will be presented to "the person responsible for the development of stud welding applications or studs which shall be judged most significant on the basis of (1) reducing costs for industry or (2) improving the appearance, serviceability and life of a product or structure or (3) performing a function not possible by any other method." In addition, the engineering school or college whose students and faculty shall have submitted the most outstanding group of entries in this competition will be presented with a complete stud welding unit, including gun, timer and a generator power source, valued at approximately $1500.

Entry blanks and information on this competition may be obtained from Gregory Industries, Inc., Lorain, Ohio. Entries should be mailed to Dr. Donald S. Clark, Chairman, Gregory Award Committee, 7301 Euclid Ave., Cleveland 3, Ohio, and must be postmarked before midnight June 30, 1957.

INTERNATIONAL WELDING NEWS

IIW Commission XI— Pressure Vessels, Boilers and Pipe Lines

By Arthur R. Gatewood

The scope of Commission XI covers the general study of all problems raised by the application of welding to the construction of pressure vessels, boilers and pipe lines. Originally the group existed as a working group of Commission XV, which covers fundamentals of design and fabrication for welding. Pressure vessels, boilers and pipe lines, however, constitute a field so large and specialized that the Governing Council, at the 1954 Annual Assembly in Florence, felt it proper to give this group status as a separate Commission. The United States was not represented by an official delegation at any of the meetings of this Commission until this year in Madrid.

The actual work of Commission XI is carried on by two Subgroups. Subcommission 1 is studying welded connections as applied to pressure vessels and the work so far presented is a compilation of some of the types used in various countries. They are not intended to be mandatory or restrictive in any way but in order to be of value to designers it will be necessary to have comments from as wide a field as possible, not only as to whether there has been a bad experience with any of the types of connections which have been included but also as regards any unusual difficulty in carrying out the welding. This particular Document, together with the illustrations, was published in "*Welding Research Abroad*" for July 1956 and it is hoped that comments will be received regarding American experience.

So widespread has become the use of welding that its impact on design is felt on the simplest to the most complicated structures and a large part of the effort of Commission XI is being devoted to this problem. It will be realized that any weld will result in a stress concentration and it is therefore necessary to evaluate the effects of the concentrations due to welding against the other stress concentrations which are inherent in a particular design. Detailed studies of this nature have inevitably led to new theories, not only with regard to the effects of welding but also to the behavior of certain types of construction during testing and in service. In order to prove or disprove theories it is, of course, necessary to evaluate them in the light of scientifically conducted tests. In Europe this latter type of work is carried out primarily by individual organizations while in this country a considerable amount of similar work is carried on by the Pressure Vessel Research Committee of the Welding Research Council.

One of the theories presently being considered by Subcommission 2 is based on two simple ideas. The first is that no portion of a vessel must yield throughout its thickness. The second is that, in low-carbon and low-alloy steel vessels, corrosion fatigue fracture would occur before plastic fatigue fracture and that it would require repeated yield and reverse yield to start it. Obviously the second of these ideas has not been generally accepted and plans are being made for obtaining experimental evidence to demonstrate the effectiveness of avoiding repeated yield and reverse yield. A paper discussing these concepts entitled "Stresses in Welded Pressure Vessels" by W. P. Kerkhof, Chairman of Commission XI, was published in the January 1956 issue of THE WELDING JOURNAL Research Supplement.

Another Document entitled "Pressure Vessel Design" by Dr. W. B. Carlson, who is Chairman of Subcommission 2, was published in *Welding Research Abroad* for April 1956. It is based on the same concept but discusses in detail a method for determining the factor by which the design stress should be increased to arrive at the permissible stress with regard to the two limiting types of concentration, i.e., any combination of pure membrane and bending stress, or any combination of pure membrane and highly localized stress such as a notch. This latter document was accepted as a Tentative Document at the meeting in Madrid for distribution and comment.

Subcommission 2 is also working on a Document specifically covering the application of this theory to domed ends for pressure containers but this work is not yet ready for distribution.

It will be noted that while the work of Commission XI is being carried on by representatives from a number of different countries, it is their feeling that the Documents will be of maximum benefit only if they can be brought to the attention of many more designers for consideration and comment. There was considerable discussion at Madrid as to how this might best be accomplished. One method has been to pass such reports to ISO TC/11 for their information and comment as they are the international standardizing organization for this type of work. The Chairman also cited THE WELDING JOURNAL and *Welding Research Abroad* and praised them very highly for their dissemination of such information. He recommended that the other Delegations explore the possibility of having their national organizations find similar or other equally effective means for presentation of the Documents, with particular emphasis on the thought that if the Documents are to be of real benefit to designers they must receive widespread critical appraisement.

Arthur R. Gatewood is the American delegate on Commission XI of the IIW.

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NEW WELDING IGNITRON TRADE-IN PLAN REDUCES MAINTENANCE COSTS

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TUBE TYPE	SALVAGE ALLOWANCE*	SPECIAL FEATURES
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*Any tube acceptable except those with the following defects:
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Offer good when worn out tubes are accompanied with new tube order of same types and in same quantity.

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Trade in any tube—any make! Only Westinghouse makes this great offer . . . only Westinghouse will give a salvage allowance on any make and type of welding ignitron listed. Naturally, no *rebuilts.*

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Electronic Tube Division, Elmira, N. Y.

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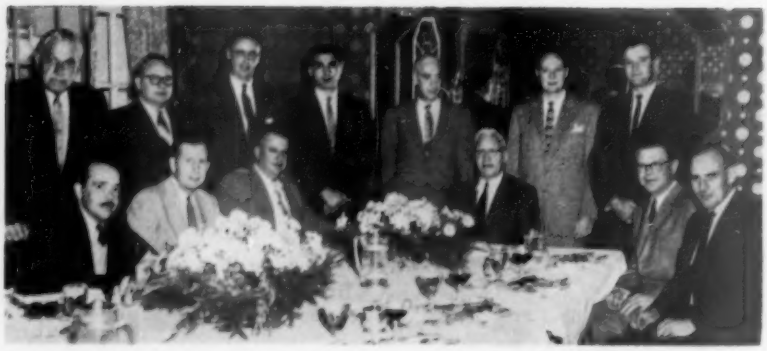
Stulz-Sickles Holds Sales Conference

Stulz-Sickles Co., of Newark, N. J., producers of Manganal, 11–13½% manganese-nickel steel welding products, held their annual sales conference on September 26th, 27th and 28th at The Homestead, Hot Springs, Va.

At the Company's Annual Dinner, an engraved silver tray was presented to B. H. Payne, chairman of the Board, in honor of his 35 years of service with Stulz-Sickles Co. Mr. Payne also marked his fiftieth year in the steel business.

Ten district sales managers from all parts of the country met with Mr. Payne, R. K. Chapin, president, and R. Bramley, sales manager, to discuss sales policies for the coming year.



Group in attendance at sales conference held by Stulz-Sickles Co. in Hot Springs, Va., on September 26th, 27th and 28th. B. H. Payne, chairman of Board, is shown seated at head of table

National Cylinder to Build Hydrogen Plant

A new hydrogen producing plant, the only one of its kind in the Twin Cities area, will be constructed in St. Paul by the National Cylinder Gas Co., Charles J. Haines, president, has announced.

The new plant will manufacture hydrogen by the electrolytic method which produces a gas with the high degree of purity required by certain specialized industries such as electronics and metallurgy. Production is scheduled to begin early next year.

The new plant will be built on a six-acre site at Front St. and Lexington Parkway where NCG already has oxygen, nitrogen and acetylene producing facilities.

Progressive Welder Makes Five Appointments

In keeping with a major realignment program of the company, Progressive Welder Sales Co., 3070 E. Outer Dr., Detroit 34, Mich., has appointed five new executives, according to an announcement by John D. Gordon, vice-president and general manager. The new appointments are:

L. F. Van Nortwick, as general sales manager, Frostrode Division of the Warren Alloy Division of the company. Mr. Van Nortwick has had wide experience in sales, advertising and general management on a national and retail level. He was formerly truck sales manager, Dodge Division, Chrysler Corp.

Bernie Walker, as assistant Director of manufacturing of all Progressive's divisions. He has a long and thorough background as master mechanic and manufacturing engineer.

Earl R. Stiefel, as director of purchases. He brings many years of experience in purchasing practice with some of the country's top manufacturers.

George W. Enk, as general sales manager, for the United States and Canadian operations of Progressive Welder Sales Co. Mr. Enk has been associated with the resistance welding field since 1945. He is a member of the American Welding Society.

E. J. Formhals, as general manager of the Canadian plant, located at Chatham, Ont., Canada. Mr. Formhals has had a long association with automotive and allied industries in the United States and Canada.

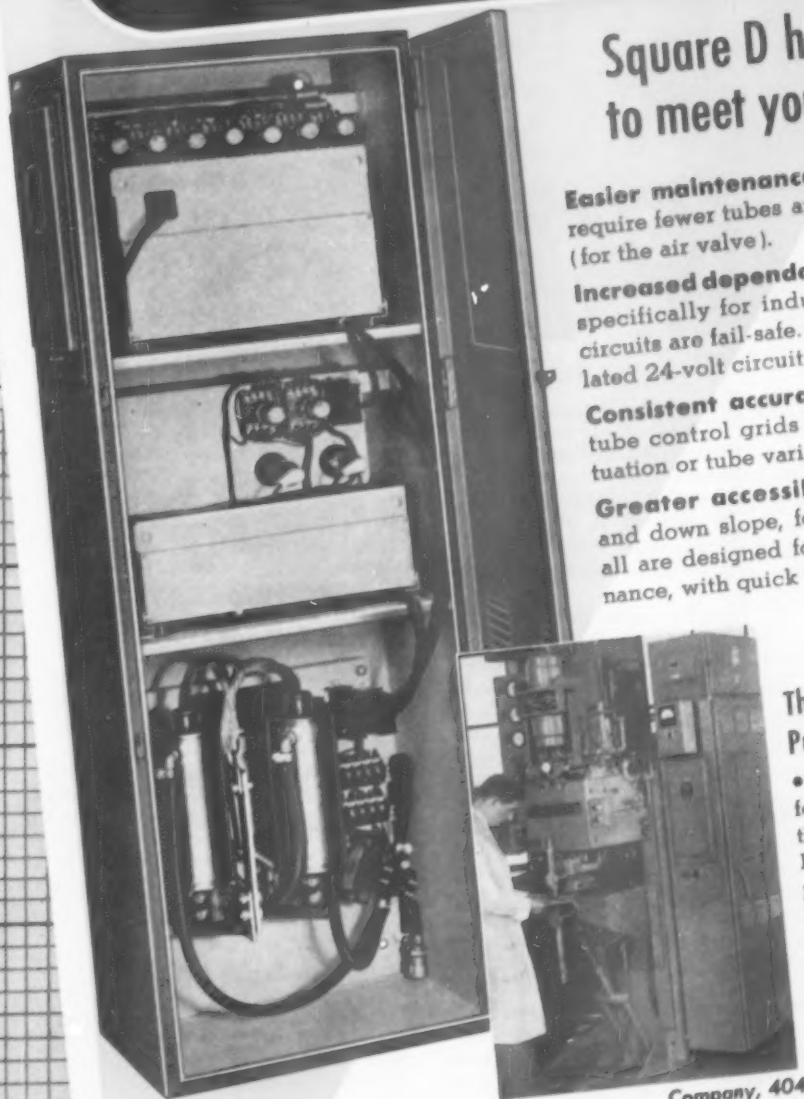
George W. Enk

CANADIAN GROUP ATTENDS WELDING INSTITUTE

Group of welders attending the Eutectic Welding Institute of Canada, assembled at the Montreal Plant of the Eutectic Welding Alloys Co. of Canada Ltd. This Institute is open to welders and other maintenance personnel from any Canadian company

Stainless Steel? Aluminum? Magnesium? Air-Hardenable Steels? Low Carbon Steels? Aluminum-Magnesium Alloys?

What's Your Precision Welding Problem?



Square D has the control to meet your exact needs!

Easier maintenance Vastly simplified circuits require fewer tubes and only one operating relay (for the air valve).

Increased dependability Components designed specifically for industrial welder service. Tube circuits are fail-safe. Initiating contacts are in isolated 24-volt circuit.

Consistent accuracy Regulated DC voltage on tube control grids compensates for supply fluctuation or tube variations.

Greater accessibility Timer, heat control, up and down slope, forge and chill temper panels—all are designed for easy inspection and maintenance, with quick fasteners and plug connectors.

Thomson Electric Welder Company Puts Square D Control to "Acid" Test

• This Thomson Welding Machine is used for experimental and "special" jobs in the Thomson laboratory. It has put Square D control to the "acid test" in scores of precision operations. It has made crack-free welds in a variety of aluminum alloys in gauge thicknesses up to .072". It has made excellent welds in air-hardenable steels and in ½" diameter steel bars.

Write for Bulletin 8993. Address Square D Company, 4041 N. Richards Street, Milwaukee 12, Wisconsin. Or consult your nearby Square D Field Engineer.

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GRADUATE ENGINEER

Excellent opportunity for a recent or experienced graduate engineer or equivalent who has a desire to become familiar with or has experience in welding. The applicant selected will assist in research, development and production of welding processes and act as consultant to other sections. Experience in aircraft manufacturing preferred. Salary commensurate with experience and ability to work with high degree of independence.

At Republic you will enjoy an exceptional employee benefit program which includes company-paid hospitalization insurance, surgical insurance, accident and life insurance, 2-fold pension plan, tuition (⅔), individual merit rated increases PLUS Long Island living—the most diversified way of life in America . . . in sports and recreation, in culture, in social pursuit.

Please send résumé including details of your technical background to:

Mr. Charles J. Ketson
Employment Manager

REPUBLIC AVIATION

Farmingdale L. I., N. Y.

District Changes Announced by Air Reduction

A. S. Blodget, Jr., district manager for the Air Reduction Sales Co. sales office in Pittsburgh, has been appointed regional sales manager with offices in New York City, and Sam S. Bruce, Jr., Chicago district manager, succeeds Mr. Blodget as district manager in Pittsburgh, it was announced by H. F. Henriques, vice-president.

A. S. Blodget, Jr.

G. J. Dekker, district manager in Milwaukee, has been named Chicago district manager succeeding Mr. Bruce. It was also announced that the Chicago district has been expanded to include the Milwaukee area. C. F. Woelm, assistant sales manager, Milwaukee, has been made branch manager at that location.

Mr. Blodget joined Airco in 1938 and served in the U. S. Navy for 4½ years, from 1941 to 1946. He returned to the company as salesman in Boston; later became branch manager in Worcester, Mass., and in 1950 was appointed district manager in Boston. He has been the Pittsburgh district manager since 1952.

Mr. Dekker, with the company since 1919, has held various important sales posts including managerial positions at Cleveland, Grand Rapids, Oklahoma City, Detroit and St. Louis. He has been manager of the Milwaukee office since 1953.

Sam Bruce, Jr., came with Air Reduction in 1946 and held various positions in the Railroad Department including sales representative and zone manager for the eastern region. He was Chicago district manager from 1954 up to the present time.

Clarence Woelm joined Airco in 1932 and came up through the ranks at the Milwaukee office, from clerk to his new position of branch manager.

The Messrs. Blodget, Dekker and Bruce are members of the AMERICAN WELDING SOCIETY.

Joseph Co. Holds Welding Show

The E. R. Joseph Co. of Norristown, Pa., had a three-day Welding Show on September 11th, 12th and 13th. Fifteen suppliers demonstrated their products. Between 400 and 500 customers attended this affair, which was held in the afternoon and evening.

The Show was held in the new 4000 sq ft building which, when completed, will handle warehousing activities.

National Cylinder to Expand

National Cylinder Gas Co. will begin work immediately to expand its electrolytic hydrogen producing plant in Los Angeles, it has been announced. Capacity will be boosted by approximately 70%. Plans for the enlarged plant provide for further increases in capacity as required by future developments.

Ignitron Salvage Program

A welding ignitron salvage program has been put into effect by the Westinghouse Electric Corp.'s electronic tube division, Elmira, N. Y.

Each used ignitron tube of sizes 5551, 5551A, 5552, 5552A, 5553, 5553B will have salvage credit value when accompanied by an order for a new tube of like size and for equal quantities.

For complete details, write directly to company at the above address.

Nelson to Expand Facilities

A 30% expansion of manufacturing and engineering facilities at the Lorain (Ohio) plant of the Nelson Stud Welding Division has been authorized by the board of directors of Gregory Industries, Inc.

Construction will start as soon as possible on the plant addition, it has been announced. Some 15,000 sq ft will be added to the present 55,000 sq ft at 28th St. and Toledo Ave. in Lorain. New production equipment is due to be delivered in 1957.

...for those tough "HARD to WELD" jobs

VICKERS Controlarc* DC Welder

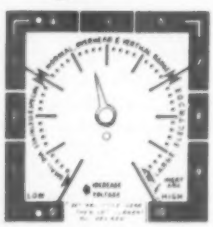
Gives You REMOTE CONTROL of CURRENT and TYPE of ARC

Even in those tight, cramped places, where there's hardly room to turn around, this handy little remote control box goes right with you. No matter what your welding position, you can "dial" the exact arc you need, without running back to the welder to change range switches and taps. Only the Vickers CONTROLARC gives you this individual control of current and type of arc in convenient remote control operation.

AND ONLY THE CONTROLARC GIVES YOU THESE EXCLUSIVE OPTIONAL FEATURES

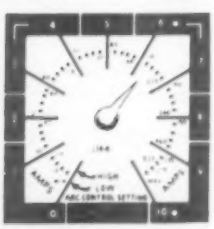
Constant Potential (CP) Adaptor • Slope Controller

Right at your fingertips—exact control—compact, light weight for truly versatile performance



SELECTION OF ARC TYPE

for different welding jobs, and adjustment necessary to suit your individuality and the welding job.



DUAL CONTINUOUS CONTROL

in a rectifier welder. Can vary the current from minimum to maximum, and vary the type of arc, with continuous stepless self-indicating dials.

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VICKERS INCORPORATED a unit of Sperry Rand Corporation

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RESISTANCE WELDER EXECUTIVE-ENGINEER

Immediate top level opening for qualified resistance welder engineer combining creative design talent with executive ability. Must have thorough knowledge of resistance welders with at least eight years design experience. Offers excellent salary to match ability with ideal living near cultural Boston in the heart of famed New England recreational areas.

Write for interview giving personal history and experience in detail. Address General Manager,

THOMSON ELECTRIC WELDER CO.

161 Pleasant Street,
Lynn, Massachusetts

Welding Progress Awards

Herman Tachau of Santa Fe, N. Mex., an engineer with the New Mexico State Highway Department, received the first award of $5000 in the recent competition for ideas to accelerate the progress of arc welding sponsored by The James F. Lincoln Arc Welding Foundation of Cleveland, Ohio. The award was one of 20, totaling $20,000, made to men in 16 different states.

Mr. Tachau received the award for a complete and thorough outline of a plan to enable more engineers to design machines and structures for arc welding rather than some other metal joining method. The general theme of most of the ideas submitted emphasized this need for greater education of the general public to the inherent advantages and economy of welded design in machines and structures of all types. Mr. Tachau particularly pointed to the structural field where he claimed a potential of some $3^1/_2$ million tons of steel now riveted or bolted could be welded, realizing a savings in material used of about 20%.

The second award of $4000 went to Van Rensselaer P. Saxe, a consulting engineer of Baltimore, Md. T. C. Kavanagh, a consulting engineer of New York City received the $3000 third award. Bruce G. Johnston, a professor of structural engineering at the University of Michigan, received $2000 and Orville T. Barnett and John Rudy, both of the Armour Research Foundation of Chicago, shared the $1000 fifth award.

EMPLOYMENT SERVICE BULLETIN

Position Vacant

Welding engineer. Formal education and practical experience required. Experience in resistance, spot and seam, and high-temperature alloy welding used in aircraft industries. Also experienced in fusion, helio arch, atomic hydrogen, submerged arc and CO_2 gas welding. Send résumé to Technical Placement, Firestone Tire & Rubber Co., Akron, Ohio.

Services Available

A-692. Welding engineer, metallurgical. Seeking supervisory role. Experienced in all welding processes; ferrous and nonferrous metals; developmental investigations; estimating and production scheduling.

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WELDING ENGINEERS

METALLURGISTS

Openings in welding and heat treating of ferrous and non-ferrous metals. Work involves development of metallurgical processes and solution of production problems.
Graduate metallurgists and mechanical engineers without experience will be considered.
Also non-graduates with sufficient experience.
Enjoy liberal benefits including joint company-employee group insurance plan and retirement plan, plus salary commensurate with education and experience. And all this with a Division of General Dynamics Corporation — second to none in the aircraft industry.

Send Resume of Training and Experience to
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FORT WORTH, TEXAS
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REPRESENTATION WANTED

Organization or individuals now selling welding equipment and seeking a better connection. We build portable welding guns, standard welders, special welding machines and automation welding equipment. This is a young firm with lots of go looking for top notch men. We are now building for the large manufacturers and can support your efforts with creative designing and manufacturing ability.

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PERSONNEL

Daniels Appointed by Department of Commerce

The United States Department of Commerce, Business and Defense Services Administration, has announced that E. A. Daniels, vice-president in charge of sales, Victor Equipment Co., San Francisco, has been appointed to serve for an indefinite period as a member of the Welding Equipment Industry Advisory Committee.

Mr. Daniels is a member of the AMERICAN WELDING SOCIETY.

Hobbie Appointed District Manager

N. H. Hobbie, assistant sales manager of the Air Reduction Sales Co. district sales office in Charlotte, N. C., has been appointed district manager, effective Oct. 1, 1956. Mr. Hobbie succeeds the late J. B. Davenport.

Mr. Hobbie, a native of Roanoke, Va., attended the Virginia Military Institute and holds a B.S. degree from Roanoke College. During World War II, from 1940 to 1945, he served with distinction as a fighter pilot in the Royal Air Force and Royal Canadian Air Force. He joined Airco in 1945 as a salesman in the Birmingham office. In 1950 he was appointed assistant sales manager at Charlotte, a post he has held up to this time.

J. S. Stevens, zone manager in Airco's Railroad Department, has been appointed to succeed Mr. Hobbie as assistant sales manager.

Clark Promoted by G. E.

Two new appointments to the staff of the General Electric Co.'s General Engineering Laboratory have been announced by Dr. Donald F. Wilcock, manager of chemistry and metallurgy.

Roger W. Clark has been named consulting engineer on joining processes. Mr. Clark was manager of welding for the Materials and Processes Laboratory of the Large Steam Turbine-Generator Department.

Nelson Gildersleeve has been named project planning specialist for the chemistry and metallurgy laboratory. He was manager of process instrument sales for General Electric's Instrument Department, Lynn, Mass.

Mr. Clark joined the company in 1924 and has been associated with welding since 1925. He served in the Testing Laboratory, the Factory Division of Welding Engineering and the Schenectady Works Laboratory before joining the Materials and Processes Laboratory. He has been manager of welding since 1944.

He has been active in a number of technical societies, including the AMERICAN WELDING SOCIETY, of which he is presently a Director-at-large.

Mr. Clark is a native of Paxton, Mass.

Heppel and Dieker Appointed by NCG

National Cylinder Gas Co. has appointed new district managers in Kansas City, Kan., and Lubbock, Tex. Fred C. Heppel, vice-president, said that Kenneth G. Dieker is the new Kansas City manager, and Robert L. Gabbard has taken over the Lubbock post. Mr. Dieker was NCG manager in Lubbock for the past year and Mr. Gabbard served as manager of the firm's branch office in Fort Smith, Ark., since July 1954. Mr. Dieker is a member of the AMERICAN WELDING SOCIETY.

Aaron Appointed by Tour

Martin Aaron has been appointed assistant to the president of Sam Tour & Co., Inc., and its affiliate the American Standards Testing Bureau, Inc., it was announced by Sam Tour, president of both corporations.

Mr. Aaron will be in charge of customer relations and product certification programs of the American Standards Testing Bureau, Inc.

CHANGE OF RESIDENCE ADDRESS OR COMPANY AFFILIATION

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Company Name and Address ..... COMPANY NAME

..... STREET

..... CITY ZONE STATE

Title of position held .....

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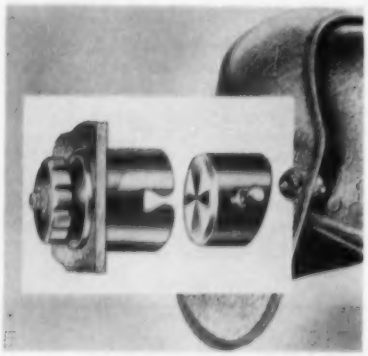
I wish to be affiliated with the ..... AWS Section

Note: To assure that your copy of the Welding Journal is mailed to your new address, this change of address notice must be received at American Welding Society, 33 West 39th Street, New York 18, N.Y., no later than the 25th of the month previous to issue mailing.

NEW PRODUCTS

Connect-Disconnect Attachment

Quick-Lok is a positive, rugged, mechanical type attachment to make complete safety units of welding helmets and SuperGard safety caps, according to its manufacturer, the Fibre Metal Products Co. It is said to be of



extremely compact design to avoid tension or spreading of the helmet shell.

The safety cap part of the attachment is a wide-based plastic molding containing a spring-loaded plunger lock that is depressed in order to dovetail with the helmet section. The helmet part of the attachment is protected by the helmet and is built integral with the friction adjusting mechanism.

Further information may be obtained by writing the Fibre-Metal Products Co., Chester, Pa. (Quick-Lok is described by Bulletin No. 49.)

A-C, D-C Electrode

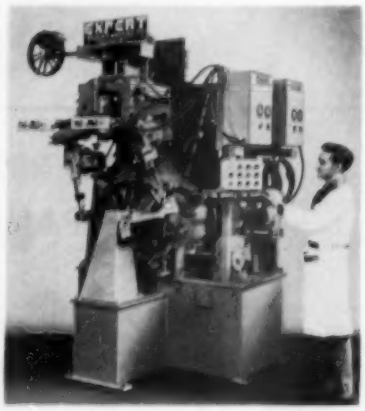
Eutectic Welding Alloys Corp. announces that two of its electrodes, EutecTrode 68 AC and 680 DC, have been combined in a-c, d-c electrode for high-alloy steels.

The new EutecTrode 680 AC-DC is available in $^5/_{32}$, $^1/_8$, $^5/_{32}$ and $^3/_{16}$ in. diam. According to the manufacturer, it produces joints with an ultimate tensile strength up to 120,000 psi and deposits take a high polish.

The EutecTrode 680 AC-DC is described in an illustrated procedure sheet, "1,001 Ways To Save With New 'Low Amp' EutecTrode 680 AC-DC," available from more than 350 Eutectic District Engineers and from Technical Information Service, Eutectic Welding Alloys Corp., 40-40 172nd St., Flushing 58, New York, N. Y.

Index Welder

A new Expert automated 8-station trunnion-type index arc-welding machine which features a unique cam index mechanism and a simple cam clamping mechanism is now available from Expert Welding Machine Co., 17144 Mt. Elliott Ave., Detroit 12, Mich. Use of these mechanical systems decreases cycle time, thereby increasing production. They also simplify over-all machine complexity.



According to the manufacturer, the machine illustrated welds, by the CO_2-shielded arc method, an outer cup and support bracket together to produce 433 automotive motor mount bracket assemblies per hour at 80% efficiency. By changing the clamping fixture, the machine can be adapted to a variety of two-piece parts which require joining with longitudinal welds. Furthermore, the basic design is adaptable to submerged-arc or argon-shielded arc welding.

For complete details, write directly to manufacturer at the above address.

A-C Welder

A new triple-rated a-c transformer-type arc welder for operation on single-phase, 60-cycle, 230-v input is being announced by Hobart Brothers Co., Troy, Ohio.

Output of this new welder at 30 v is 295 amp on 20% duty cycle, 250

amp on 30% duty cycle and 200 amp on 50% duty cycle.

The transformer is the "Diverter Path" type with magnetic control for maximum efficiency, safety and silent operation. The controls provide five main steps of coarse adjustment for use in all conventional a-c welding, as well as for certain inert-gas welding applications. Four additional steps are provided for use in certain other inert-gas welding; also usable for conventional welding, but only with E6013 type electrodes and only for downhand welding.

For complete information, write Hobart Brothers Co., Troy, Ohio.

Hand-Cutting Torch

The Oxweld C-63 a new hand-cutting torch, featuring separate oxygen lines for preheat and cutting oxygen, has been introduced by Linde Air Products Co., a Division of Union Carbide and Carbon Corp.

According to manufacturer, the new torch offers preheat capacity greater than that of any standard manual torch. Ample preheat is provided for cutting thicknesses as great as 55 in. in a single pass. Separate preheat oxygen line supply provides stable preheat flames which are unaffected by operation of the cutting oxygen valve.

Valves are separated from the main body of the blowpipe for more convenient operation and maintenance. Flashbacks are virtually eliminated by use of a cartridge-type mixer which pro-

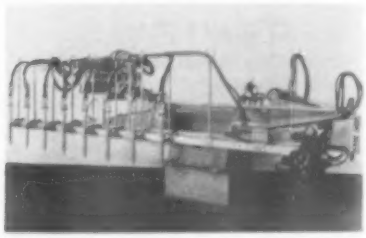
vides thorough and uniform mixing of gases. The Oxweld C-63 is designed for use with medium-pressure acetylene. Cutting nozzles are also available for use with other fuel gases. For special job requirements the C-63 is available for use with other fuel gases. For special job requirements the C-63 is available with longer lengths of stainless steel tubing to increase its normal 4-ft 9-in. length.

Additional information on the Oxweld C-63 cutting torch may be obtained by writing to Linde Air Products Co., 30 E. 42nd St., New York 17, N. Y.

Shape-Cutting Machine

A new medium area oxyacetylene shape-cutting machine, the Airco No. 56 Oxygraph, is now available from Air Reduction

According to manufacturer, the Airco No. 56 Oxygraph is designed to carry



the latest automatic cutting equipment—motorized cutting torch holders, solenoid gas distribution system and the electronic tracer—all remotely controlled from an "operator's station." The new oxygraph is capable of carrying automatic electronic welding equipment.

The machine is of the stationary type with a fixed cutting area (56-in. diam circle) but is designed for easy conversion to a larger area, unlimited length machine by the addition of rails and a traveling carriage.

For complete information about the new Airco No. 56 Oxygraph, write Air Reduction Sales Co., a division of Air Reduction Co., Inc., 150 E. 42nd St., New York 17, N. Y.

Thread Sealing Compound

The K-G Equipment Co., Inc., Allentown, Pa., has announced that they have changed the thread sealing compound used in K-G regulators. The compound is "T-Film," a teflon-base compound that is chemically inert and will not affect any of the gases used in K-G regulators. According to the K-G Research and Development Group, this is the best pipe thread compound of the many tested to date. In addition to completely eliminating leakage, the "T-Film" will permit easy removal of nipples from the regulator body for repair purposes.

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NEW LITERATURE

Electrode Catalog

A new 28-page catalog EW-195 covering 44 types of electrodes is being mailed free of charge on request to Hobart Bros. Co., Troy, Ohio. The catalog gives applications, procedures,

recommended currents, physical properties and sizes available for more than 44 Hobart electrodes. These include mild steel, iron powder, low hydrogen, special alloys, hard surfacing, aluminum, bronze and others.

Bronze Filler Rod

Ampco Metal, Inc., announces the release of a new Bulletin 56L-171 describing Ampco-Brāz No. 3, which is a new, high-strength manganese bronze filler rod of uniformly high quality for oxyacetylene welding.

Ampco-Brāz No. 3 is said to be an all-purpose, general maintenance filler rod for brazing dissimilar metals; braze-welding heavy cast iron and steel castings; repair of gear teeth, etc.; and for building up wear- and corrosion-resistant parts, such as bearings, pistons, shafts, etc.

Send direct to Ampco Metal, Inc., 1745 S. 38th St., Milwaukee 46, Wis., for your copy of Bulletin 56L-171.

Resistance Welding

Sciaky Bros., Inc., 4915 W. 67th St., Chicago, Ill., introduce a special issue of their "Resistance Welding at Work" publication, featuring a foreign application.

This literature describes and illustrates heavy resistance welding which originated from Sciaky's Paris, France, plant. It deals with fabricating of heavy steel structural members and how resistance welding has been preferred over riveting.

A sequence of photos reveal an I-beam assembly over 23 yd long and weighing about 25 tons being set up, spot welded and then installed into the framework of a French power station.

For more complete information, write direct to the above Chicago address, Department L-13, for your free special issue.

Accident Facts

The 1956 edition of the National Safety Council's statistical yearbook, *Accident Facts*, is now available. It contains facts and figures on all types of accidents—industrial, traffic, home, farm and school.

Twenty pages of this 96-page book are devoted exclusively to occupational accidents and provide the factual background necessary to give direction to an industrial safety program. There is a detailed list of accident rates by major industry groups, as well as charts showing the accident trend during the past 30 years. Most common source of injuries, part of body most frequently injured, off-the-job accident problems, unsafe acts and unsafe conditions contributing to permanent impairments and deaths, and other topics are included.

Accident Facts is priced at $1.00 a single copy and less for quantities. Inquiries should be sent to the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

Welding Positioner

Worthington Corp. has recently made available a new specification sheet on their heavy-duty, model 240 welding positioner, which includes specifications, general description and photographs.

According to the manufacturer, Model 240 is ideal for manual and automatic welding of cumbersome frames and bases, as well as for scarfing and beveling, and has a 24,000 lb maximum capacity.

Variable or constant speed table rotation and remote push button control, or foot-operated control if desired, work to the best advantage for the operator.

For further information or copies direct requests to Worthington Corp., Positioning Equipment Division, Plainfield, N. J., specifying Bulletin No. R-1700-817 P.

REVIEWS
OF NEW BOOKS

Electronics

Electronics in Industry, Second Edition, by George M. Chute, Professor of Electrical Engineering, University of Detroit. Price $7.50. 431 pages, profusely illustrated. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y.

This book presents the basic fundamentals of electronic devices as needed by men in industry, and explains how these devices are used in practical circuits. The uses of vapor or gas tubes are stressed. Several laboratory electronic instruments are discussed, as well as the many non-electronic devices often used in electronic equipment. There is little use of mathematics beyond simple arithmetic in example problems. Tubes are introduced gradually in simple operating circuits to acquaint the reader with the purpose of electronic equipment while briefly exploring the nature of the tubes themselves.

In this revision, recent designs of industrial controls are substituted throughout; those for resistance welding are covered more completely. A new chapter on closed-loop systems has been added, giving a simple but basic introduction to servos and the new field that includes automation. Feedback and servo systems are explained for those whose knowledge of mathematics is not too advanced. Brief sections have been added on transistors, magnetic amplifiers and strain gages. Polyphase rectifiers are described more completely.

Brazing News

The latest issue (No. 74) of the Handy & Harman bulletin *Low Temperature Brazing News* is now available. It features the use of Easy-Flo alloys for the brazing of bicycle frames.

For your copy, write directly to Handy & Harman, 82 Fulton St., New York 38, N. Y.

Submerged-Arc Welder

A 20-page pamphlet on "New Lincolnweld," covering the latest submerged-arc welding equipment manufactured by The Lincoln Electric Co., Cleveland 17, Ohio, has just become available.

For your copy, write directly to The Lincoln Electric Co. at the above address.

Radiography Units

A new 12-page booklet, entitled "Norelco X-ray for Industry," containing operating and application data on six different types of radiography units, is available gratis from the Instruments Division, North American Philips Co., Inc., 750 S. Fulton Ave., Mount Vernon, N. Y.

Instruments covered include: 60 kvp lightweight portable radiographic-fluoroscopic unit, 160-kvp dual-port unit, 160-kvp 360-deg circumferential port unit, 150-kv constant potential unit, 300-kv constant potential unit and 260-kvp self-contained portable unit. Information is given also on industrial image intensifier and closed-circuit television installations.

Dye Penetrant Inspection

"How to Perform Dye Penetrant Inspections" is the title of a new four-page folder issued recently by Turco Products, Inc.

Written by William D. Briggs, manager of Turco's Technical Department, the semitechnical booklet is described as a "manual of established and proved rules" for performing inspections by the penetrant process, and is the first comprehensive report to be written on this vital subject.

The booklet thoroughly discusses every aspect of penetrant flaw location —precleaning, applying penetrant, removing excess penetrant, applying developer and interpreting results. Special emphasis is placed on the precleaning step, and methods of removing all types of soil are thoroughly outlined.

Copies of the booklet may be obtained by writing to Turco Products, Inc., 6135 S. Central Ave., Los Angeles 1, Calif.

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AMPCO-WELD holders — delivery from stock of straight, offset, or universal ejector types. Offset and universal holders have interchangeable sockets for No. 1 and 2 tapers.

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125	388	1050
138	400	1100
150	413	1150
163	425	1200
175	438	1250
188	450	1300
200	463	1350
213	475	1400
225	488	1450
238	500	1500
250	550	1550
263	600	1600
275	650	1650
288	700	1700
300	750	1750
313	800	1800
325	850	1850
338	900	1900
350	950	1950
363		2000

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The sturdy Taylor Velocipede frame of 2-inch mild steel tubing is braze-welded on this fixture, with ⅛-inch Anaconda-997 (Low Fuming) Bronze Welding Rod, using the oxyacetylene flame-fluxing process.

"...quickest, most dependable, most economical..."

"Braze Welding with Anaconda 997 (Low Fuming) Bronze Welding Rod is the most practical method of joining steel tubing," The Frank F. Taylor Co.

The strategically placed braze welds on Taylor Velocipedes have smooth contours, a good basis for a fine finish—and high strength to stand up in the hardest service. The Frank F. Taylor Co. also makes the famous Taylor-Tot, standard equipment in most young families.

"By depositing smooth flowing and low fuming weld metal, Anaconda-997 (Low Fuming) Bronze Welding Rods promote faster, more uniform work—providing the quickest, most dependable, most economical method of joining steel tubing," says The Frank F. Taylor Company of Norwood, Ohio.

Anaconda 997 (Low Fuming) Bronze is a superior braze-welding rod widely used for the joining of steel, cast iron, and copper alloys by the oxyacetylene process. It is also used to deposit bearing surfaces on steel and iron. Anaconda Welding Rods are sold by distributors of welding equipment everywhere, such as O.K.I. Welding Company, Cincinnati, Ohio, which supplies The Frank F. Taylor Company.

See your Anaconda distributor for help in selecting the exact rod for your job. Or write for Publication B-13. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Company Ltd., New Toronto, Ont.

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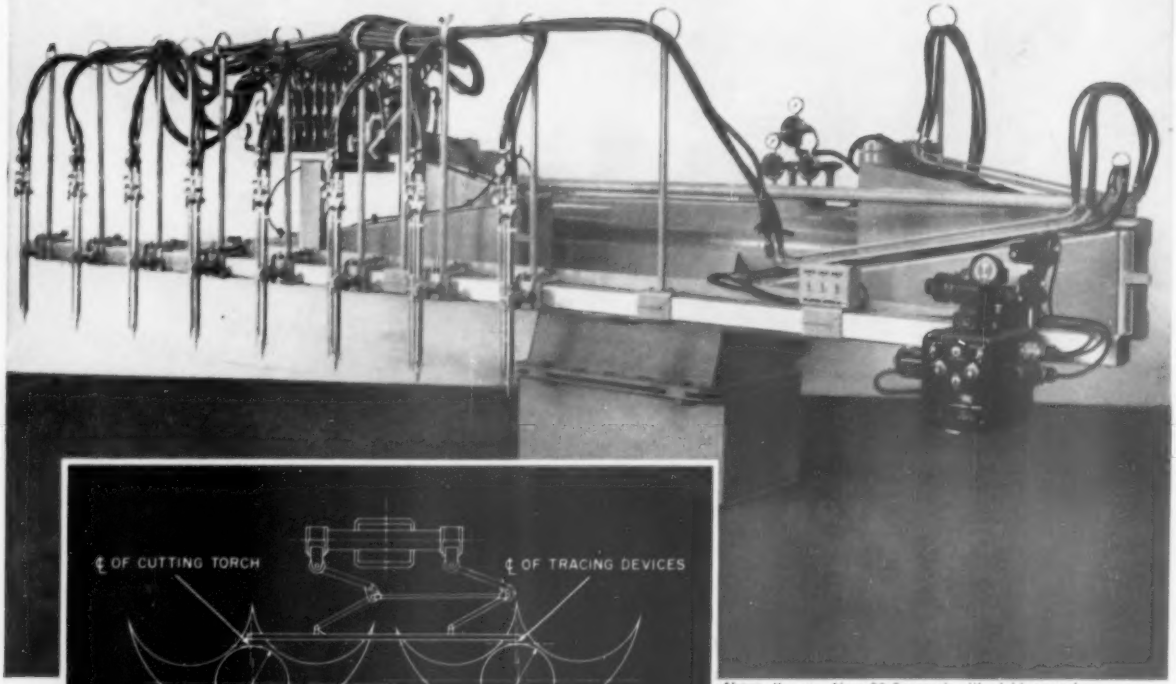

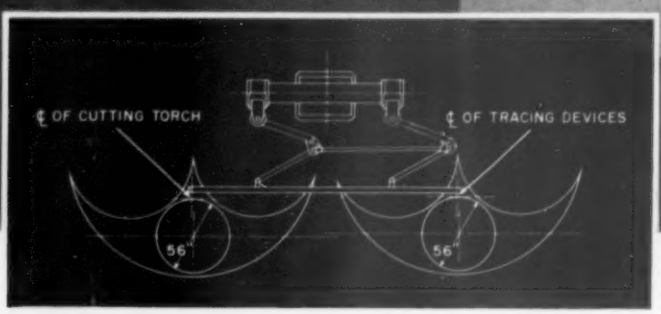

Above: the new Airco 56 Oxygraph with eight manual torches. All-welded construction provides unusual sturdiness and durability.

At left: drawing shows great versatility in patterns that can be cut with the new model 56.

NEW... Airco 56 Oxygraph

...for better machine gas cutting of larger work on production schedules

This newly developed Airco 56 Oxygraph meets the demand for a multi-torch oxy-acetylene shape cutting machine that will handle substantially large areas. It *cuts* a *full 56" circle*, and corresponding square and rectangular shapes. Rugged box girder design is used for the pantograph arms, holding vibration to a minimum. Tracer response is smooth and friction-free as a result of large diameter ball bearings in the pantograph hinges and operating bar assembly.

This newest of Airco Oxygraphs will cut an unlimited variety of shapes from steel plates, slabs, billets and forgings. Flexibility of design allows amplifying scope of machine to meet increased shop demands. Tracers are available in four types: electronic, manual, magnetic and spindle. This widened capacity of the new model 56 marks another step forward in welding and cutting progress. For detailed information on the New 56 Oxygraph, write direct to Airco.

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